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SEGMENTATION OF THE OVUM, WITH ESPECIAL REFERENCE TO THE MAMMALIA.

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THERE follows after impregnation a short pause, and then the ovum begins its process of repeated division, which is known as the "*segmentation of the ovum*," the term having been introduced before it was known that each "segment" is a cell. The division or cleavage (Furchung) of ova was described by Prevost and Dumas, 1824, and again by Rusconi in 1836. By usage, the term segmentation is restricted to the production of cells up to the period of development, when the two primitive germ-layers are clearly differentiated and the first trace of organs is beginning to appear.

Segmentation nucleus. The impregnated ovum has a single nucleus which is known as the segmentation nucleus, and which is formed by the union of the male and female pronuclei.[1] It is the parent of all the nuclei subsequently found in the organism, and participates actively in the process of segmentation. It is very much smaller than the nucleus of the egg-

[1] Ed van Beneden in his first paper, Ascaris, **11,** affirmed that there was no real union of the pronuclei in the impregnated ova of that species, but Carnoy, **18,** showed that van Beneden's observations were incomplete, and Zacharias has stated, **50,** that they are so defective as to be fundamentally erroneous in regard to important phases, and he points out that in reality the eggs of Ascaris offer another proof of the actual union of the pronuclei. The impregnation in this Nematod has since formed the subject of numerous articles, see van Beneden and Neyt, **12,** Carnoy, **182,** Boveri, **15,** etc., etc.

cell before maturation; it is usually membranate, and has numerous fine granules of chromatine, *microsomata*, derived from the pronuclei; in some cases the microsomata from the male pronucleus are distinguishable from those of female pronucleus. In the rabbit the nucleus when first formed has indistinct contours, an irregular shape and a homogeneous appearance (Ed van Beneden, 8, 699,) it soon enlarges, becomes regular, and acquires a distinct, centrally situated nucleolus, (Bischoff, 14, 50, Coste 17, Lapin Pl. ii. fig. 4,) presumably by the gathering together of the microsomata.

The position of the nucleus is always eccentric[1] so far as known, and approximately if not exactly the same as that of the egg-cell nucleus before maturation; accordingly, the degree of eccentricity varies as the amount of yolk or deutoplasm being least in alecithal and greatest in telolecithal ova. In brief, it may be said the nucleus tends to take the most central position possible with regard to the protoplasm of the ovum. The vitelline granules are not to be regarded as protoplasm, hence their accumulation may produce a one-sided distension without, however, in the least disturbing the uniform *radial* distribution of the protoplasm. The nucleus is surrounded by protoplasm with few or no yolk grains; in telolecithal ova the perinuclear accumulation is the court of protoplasm at the animal pole.

Period of repose. After the segmentation-nucleus is formed, there occurs a pause, which lasts according to observations on several invertebrates, from half to three quarters of an hour. It is probable that a similar pause ensues in the mammalian ovum, but there are as yet no observations to show whether it occurs or not. During this period the yolk expands slightly, unless, indeed, the expansion observed is due to the influence of hardening agents[2] and the monocentric radiation, which is present when the nuclei copulate, gradually fades out, and is

[1] It is often stated that the nucleus lies exactly in the centre, but I have been unable to find a single observation to justify the statement.

[2] Van Beneden states that osmic acid produces an artificial expansion of the ovum within the zona

replaced by a dicentric radiation which marks the end of the period of repose and the commencement of the first division of the ovum.

Karyokinesis of the ovum. Segmentation is a process of indirect cell division, and nowhere are more perfect karyokinetic figures to be found than in the segmenting ovum. It is, therefore, advisable to give a general account of the changes involved in every division, but inasmuch as karyokinesis is a phenomenon by no means restricted to embryonic cells, it is not one of the special subjects of the embryologist. I shall, therefore, attempt only a summary account, following in the main, O. Hertwig, **26,** 37-38, (compare Rabl's exhaustive memoir, **37.**)

It is probable that the resting nucleus has one pole at which the connection between the reticulum of the nucleus and the surrounding protoplasm is more intimate than elsewhere, as suggested by Rabl, **38.** This pole is marked by a clearer spot outside the nucleus, close against it and much smaller than it. This clear spot becomes the centre of the radiating arrangement of the protoplasm. It was, I believe, first observed by Flemming in the eggs of Echinoderms, has been seen in *Ascaris megalocephala* by van Beneden and Neyt, **12,** and by Boveri, **15,** in Siredon by Kolliker, 28, and in other cases. It is now designated as the sphere of attraction,[1] and is seen, at least in certain phases, to contain a separate central body (centrosoma of Boveri). It is not improbable that the "sphere of attraction" is identical with the *Nebenkern* of recent German writers. In a number of instances a small part of the nucleus is seen to separate off and to lie as a distinct body, *Nebenkern,* alongside the nucleus; this body has a colorable portion which is comparable to the "centrosoma." For an account of the scattered observations on the *Nebenkern,* together with the relation of these bodies to Gaule's so-called cytozoa, see G. Platner, **34,**

[1] The history and significance of the spheres of attraction as here presented cannot, by any means, be regarded as final. The observations are few, and in *most* cases the exact history of the spheres of attraction has received no attention from investigators whatsoever.

for additional observations see Prenant, **35**, and Platner, **34a**.

The sphere of attraction divides, as does also its central body, and its two parts move to opposite sides of the nucleus. There thus appear two opposite accumulations of clear protoplasm, from each of which as a centre, astral rays or radiating lines are formed in the cell-body. Meanwhile, within the nucleus, changes go on; the threads of the intranuclear network radiate out from the the pole where the sphere of attraction lies before its division, and the chromatic substance forms a number of distinct grains. When the sphere of attraction divides and its halves go asunder, the nuclear substance preserves its radiating relation to each sphere, and as the membrane of the nucleus disappears during these changes, the final result of the transformation of the nucleus is a spindle-shaped body, the points of which rest just within the clear centre of each astral system, so that the spindle stretches from one protoplasmic mass to the other. The spindle consists of fine threads extending from pole to pole and having almost no affinity for the dyes of the histologist, a peculiarity which causes them to be known as the achromatic threads. These threads are probably always compounded of a considerable number of exceedingly fine fibrillæ, see Rabl, **38**, 21-22. The colorable substance forms a number of separate grains, each of which is united with one of the achromatic threads, and all of which lie at the same level in the centre of the spindle; when the spindle is seen from the side, the chromatine grains appear to constitute a central band or disc (Strassburger's *Kernplatte*) but when the spindle is seen endwise, the separate grains are at once recognized. The shape of the grains is variable; some authors, without sufficient observational proof, have advanced the opinion that the grains are *always* V-shaped. The spindle together with the polar accumulations of protoplasm and the two accompanying radiations constitute a so-called *amphiastere*.

The domain of the radiation extends, the two protoplasmatic centres move further apart, the nuclear spindle elongates correspondingly, and the chromatic grains of the *Kernplatte*

divide. Flemming maintains that the division is always lengthwise of the V-shaped grain, but this has been controverted by Carnoy. How the division occurs in the mammalian ovum is unknown. By division, however it is effected, the number of chromatine grains is doubled; they form two sets; one set moves toward one pole, the other towards the other pole; the grains of each set keep at the same level as they move, until they reach the end of the spindle, where they appear as a polar disc (Carnoy's couronne polaire). Next the achromatic threads of the spindle break through and are apparently drawn in towards each polar crown. There are now two nuclear masses, each near but not at the centre of a radiation, and each consisting of chromatine and achromatic substance, each mass develops into a complete membranate nucleus, but the steps of this process have yet to be followed in detail in the vertebrate ovum.

The signs of division of the protoplasm usually become visible about the time the polar crowns are formed, but when the ovum contains much deutoplasm the division may be retarded. In the plane which passes through the equator of the nuclear spindle, there appears a furrow on the surface of the ovum, which gradually spreads and deepens until it is a complete fissure around the cell, it cuts in deeper until at last only a thin stalk connects the two halves of the cell, and thereupon the stalk breaks and the cell is divided. There next ensues a pause, during which the astral rays of the protoplasm disappears in the daughter cells, and the daughter nuclei assume each the form of an ordinary resting membranate nucleus.

The external appearances of segmentation in the living ovum vary, of course, especially according to the amount and distribution of the yolk material. The appearances in holoblastic ova with very little yolk are well exemplified by *Limax campestris*. Mark's description, **32**, is, nearly in his own words, as follows:

"In Limax, after impregnation, the region of the segmentation nucleus remains more clear, but all that can be distinguished is a more or less circular ill-defined area, which is less

opaque than the surrounding portions of the vitellus. After a few moments, this area grows less distinct. It finally appears elongated. Very soon this lengthening results in two light spots which are inconspicuous at first, but which increase in size and distinctness, and presently become oval. If the outline of the egg be carefully watched, it is now seen to lengthen gradually in a direction corresponding to the line which joins the spots. As the latter enlarge, the lengthening of the ovum increases, though not very conspicuously. Soon a slight flattening of the surface appears just under the polar globules, the flattening changes to a depression (Fig. 1) which grows deeper and becomes angular. A little later the furrow is seen to have extended around on the sides of the yolk as a shallow depression, reaching something more than half way toward the vegetable or inferior pole, and in four or five minutes after its appearance the depression extends completely around the yolk. This annular constriction now deepens on all sides, but most rapidly at the animal pole; as it deepens it becomes narrower, almost a fissure. By the further deepening of the constriction on all sides there are formed two equal masses, connected by only a slender thread of protoplasm, situated nearer the vegetative than the animal pole, and which soon becomes more attenuated and finally parts. The first cleavage is now accomplished. Both segments undergo changes of form, they approach and flatten out against each other, and after a certain time themselves divide.

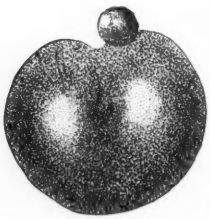


Fig. 1. Ovum of Limax campestris, during the first cleavage. Magnified 200 diameters. The envelopes are not drawn in. (After E. L. Mark.)

Primitive type of segmentation. In the lower animals there is not found that excessive amount of deutoplasm in the ovum which is so characteristic of the vertebrates, and in their ova we have what is undoubtedly the earlier and more primitive type of segmentation. In these cases the cleavage extends as in the egg of Limax, (see above) through the whole of the dividing cell. The two cells first produced are almost if not

quite alike, and each of them produces two cells which are also very similar to one another; then comes a division of the four cells into eight, four of which resemble one another and differ from the remaining cells which are also similar among themselves. Four of the cells are derived chiefly from the substance of the animal pole of the ovum and are very protoplasmic; and the other four cells are constituted out of the substance of the vegetable pole and accordingly contain most of the deutoplasm of the ovum. The eight cells form an irregular spheroid, in the centre of which there is a space between the cells; this space is known as the segmentation cavity.

The four cells of the animal pole progress in their divisions more rapidly than the four of the vegetable pole, but the latter when the yolk matter is at a minimum, as, for instance, in echinoderms, do not lag much. From their unequal rates of division the two sets of cells come to differ more and more in size, those of the animal pole being much the smaller. The division of the cells take place so that the cells form a continuous layer of epithelium, one cell thick, stretching around the enlarged central segmentation cavity, (Fig. 2) and, the latter being an outside view of an Amphioxus blastula, *cf. infra;* the epithelium consists of a larger area of the small cells of the animal pole, and a small area of the large cells of the vegetable pole. This stage of segmentation is known as the blastula stage; the small cells are destined to form the *ectoderm* of the embryo; the large cells the *entoderm;* the central space is the *segmentation-cavity;* the line along which the two parts of the epithelium (ectoderm and entoderm) join is known as the *ectental line.*

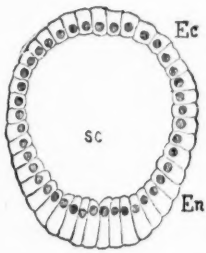


Fig. 2. Blastula of Echinocardium cordatum 20 hours after impregnation *Ec*, ectoderm; *en*, entoderm; *sc*, segmentation cavity. After Selenka.

Vertebrate type of segmentation. In the vertebrates we find that segmentation also results in two epithelia, one ectoderm and one entoderm, joined at their edges, and

surrounding a segmentation-cavity, but the resemblance to the typical blastula is masked by changes in both ectoderm and entoderm; the vertebrate ectoderm when first fully differentiated consists of several layers of cells, and not merely of a single layer of cells as in the primitive type of segmentation; the entoderm contains a very large amount of nutritive material (deutoplasm) and is represented either by a mass of large cells (marsipobranchs, ganoids, amphibians) or a mass of protoplasm, not divided into cells, or but partially divided into cells, and containing an enormous quantity of deutoplasm (sauropsidans and monotremes). In the higher mammals there are further modifications as described below.

The more primitive form among vertebrates is, I think, presumably, that in which the entoderm consists of separate cells, for this mode of segmentation is the one which most resembles that of invertebrates, and it occurs in the lowest vertebrates, and in ova which are not excessively charged with yolk.

In the *primitive form of vertebrate segmentation*, which is preserved in the marsipobranchs, ganoids and amphibians, there is a well marked difference between the cells of the two poles. The following account refers especially to the frog's egg, and is an adaption of Balfour's summary (Comp. Embryl. I., 78, 79). The first formed furrow is vertical; it commences in the upper half of the ovum which corresponds to the animal pole and is characterized by the black pigment—the lower or vegetable pole being whitish. The first furrow extends rapidly through the upper, then more slowly through the lower half of the ovum, so that the divergence in the two polar rates of development is indicated already. As soon as the furrow has cleft the egg into halves, a second vertical furrow appears at right angles to the first and behaves in the same way (Fig. 3). The next furrow is at right angles to both its predecessors, and therefore parallel to the equator of the egg, but it is *much nearer the animal than the vegetative pole.* It extends rapidly around the egg and divides each of the four previous segments into two parts; *one larger with a great deal of yolk, and the other smaller with very little yolk.* The eight segments or cells

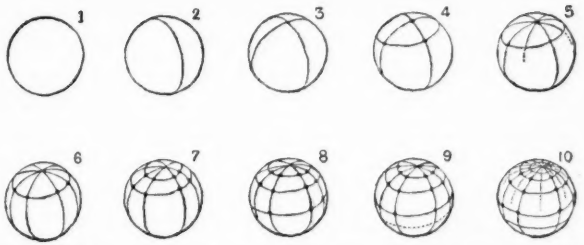


Fig. 3. Segmentation of the egg of the common frog; diagrams slightly modified from Ecker.

have a small segmentation cavity in the centre between them. This cavity increases in size in subsequent stages, its roof being formed by the small cells further divided, and its floor by the large cells, also multiplied by division, though to a less extent than the small cells. All the developmental processes progress more rapidly at the animal pole. After the equatorial furrow, there follows two vertical or meridional furrows which begin at the animal pole and divide each of its four cells into two, making eight small cells. After a short period these furrows extend to the lower pole and divide each of the large cells into two (Fig. 3, 5). The so-called *meridional* cleavages after the first and second are not truly meridional cleavages since they do not pass through the pole of the ovum, but through the poles of the cells, (blastomeres) which they divide; see Rauber, Morph. Jahrb. viii, 287.

A pause now ensues, after which the eight upper cells become divided by a furrow parallel to the equator and *somewhat later* a similar furrow divides the eight lower segments. Each of the small cells is now again divided by a vertical furrow, which later divides also the corresponding large cell. The segmentation cavity is, therefore, now bounded by 32 small and 32 large cells. After this the upper cells (ectoderm) gain more and more in number beyond the lower cells (entoderm). After the 64 segments are formed, two equatorial furrows appear in the upper pole before a fresh furrow arises in the lower, making 128 ectodermal cells against only 32 entodermal.

The regularity of the cleavage cannot be followed further, but the upper pole continues to undergo a more rapid segmentation than the lower. At the close of segmentation the egg forms a sphere, containing an excentric segmentation cavity (Fig. 4, *s. c.*) composed of two unequal parts, an upper arch of several layers of cells, (*Bl.*) the primitive blastoderm of Minot or ectoderm, and a lower mass (*Yolk*) of large cells rich in protoplasm. At the edge of the mass of large cells (*k w*) there is a gradual passage in size to the cells of the blastoderm, and it appears that the small cells receive additions at the expense of the large ones; this zone corresponds to the so-called germinal wall of large vertebrate ova, and also to what we have defined as the ectental line.

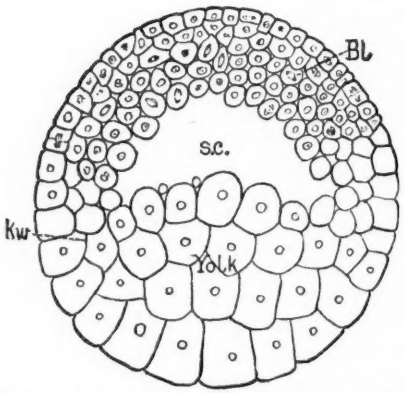


Fig. 4. Section of the segmental ovum axoloth, after Belloni, *Bl.* blastoderm; *s. c.* segmentation cavity; Yolk, yolk or entoderm; *k. w.* (keim wall) germinal wall.

The *secondary type of vertebrate segmentation* differs from the primary principally in the retarded development of the entoderm, due, apparently, to the increase of the yolk-matter. The yolk granules are, as already mentioned, found to be situated not quite exclusively, though almost so, in those parts of the ovum out of which the entodermal cells are formed. Hence, when there is a great deal of yolk the anlage of the entoderm becomes bulky, and when it segments the entodermal cells it produces are correspondingly big, as we have seen is the case in Amphibian ova. On the other hand, when the amount of yolk is small, as in the primitive type of segmentation, *e. g.* echinoderms, the entodermal cells are small. In the reverse case when the amount of yolk is exceedingly great, as in se-

lachians, reptiles and birds, the yolk may not divide into cells as fast as the nuclei multiply, so that it seems that the presence of the deutoplasm, though it does not affect the nuclear divisions markedly, certainly impedes very much the division of the protoplasm, and consequently in these ova we find at certain stages of development a multinucleate yolk. The impediment is not encountered by the protoplasm of the animal pole, hence we see the animal pole segmenting while the yolk does not; in this case the segmentation appears confined to one portion of the ovum, and accordingly such ova are termed *meroblastic* in contradiction to the *holoblastic* ova, in which the first cleavage furrows divide the whole ovum; but the difference, it must be expressly remembered, is one of degree not of kind.

The best known example of a vertebrate meroblastic ovum is, undoubtedly, the hen's egg. The so-called yolk or "yellow" is the ovum; the white and the shell are both adventitious envelopes added by the oviduct as the ovum passes down after leaving the ovary. The segmentation begins while the ovum is passing down through the lower part of the oviduct, and shortly before the formation of the shell commences. If an ovum from the upper part of the oviduct be examined, it is found to be surrounded with more or less white (albumen). Its animal pole is represented by a whitish disk from 2.5—3.5 mm. in diameter and 0.30—0.35 mm. in thickness; this disc is known by many names— formative yolk, germinal disc, cicatricula, (Narbe, Hahnentritt, Keimscheibe, stratum s. discus proligerus). The animal pole consists chiefly of protoplasm and is peculiar only in its small size compared with the whole ovum; it contains, when the ovum leaves the ovary, the egg-cell nucleus; the ovum then matures; impregnation occursand finally segmentation begins. Viewing the ovum from above, we see the first furrow appear as a groove running across the germinal disc, though not for its whole width, and dividing it into halves; this furrow is developed in accompaniment with the division of the segmentation nucleus. The primary furrow is succeeded by a second furrow nearly at right angles to the

first; the surface of the germinal disc is cut up into four segments or quadrants, (Fig. 5, A.) which are not, however, separated from the underlying substance. The number of radiating furrows increases from four, to seven or nine, when there arises a series of irregular cross furrows, by which the central portion of each segment is cut off from the peripheral portion giving rise to the appearance illustrated by Fig. 5, C; there are now a number of small central segments surrounded by large, wedge-shaped external segments. Division of the segments proceeds rapidly by means of furrows running in va-

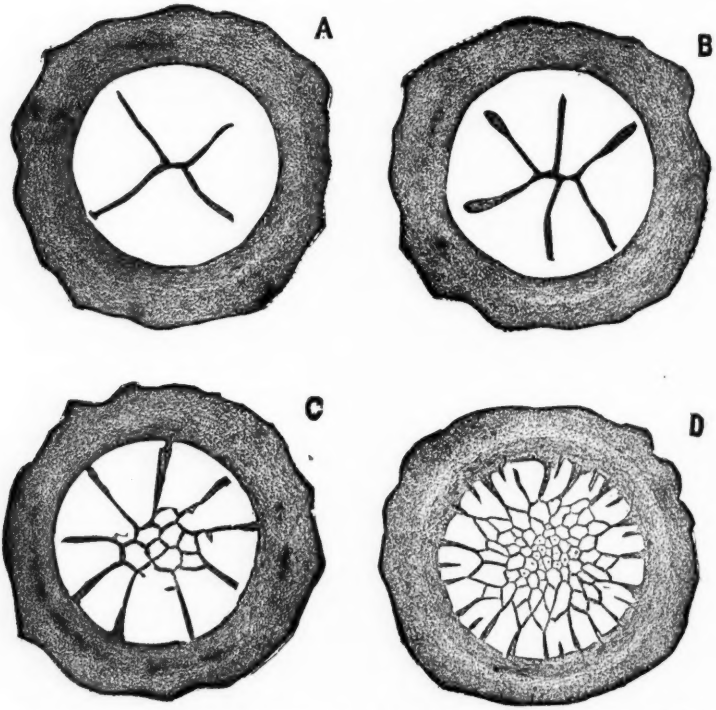


Fig. 5. Four stages of the segmentation of the hen's ovum; after Coste. Only the germinal disc seen from above and part of the surrounding yellow yolk are represented.

rious directions. Not only are the small central segments divided into still smaller ones, (Fig. 5, D.) but their number is increased also by the addition of cells cleft off from the central ends of the large peripheral segments, which are themselves subdivided by additional radiating furrows (Fig. 5, D.). Sections of the hardened germinal disc show that segmentation is not confined to the surface, but extends through the protoplasmic mass of the animal pole, there being deep seated cleavage in planes parallel to the surface of the ovum. According to Duval, **19**, when the first few, small central cells are separated off there is a small space between them and the underlying egg substance (see Figs. 2, 3, 4, 5 and 6 of his Plate I.) and this space he calls the segmentation cavity; but in this, I think, he is in error, for the cells formed below this space are incorporated in the ectoderm or primitive blastoderm; the cells referred to are those marked *im*, in Fig. 8 of Duval's Pl. I. The true segmentation cavity, as we have seen, is bounded on one side by entoderm. This fundamental characteristic Duval has entirely overlooked. From the processes described, there results a disc of cells, which receives peripheral additions; the border from which these additions come is known as the *segmenting zone*. The whole mass of cells derived from the germinal disc represents the ectoderm, and the segmenting zone may be homologized with the cells around the edge of the primitive blastoderm of the frog (Fig. 4, *k w*). A section through the segmented germinal disc shows the following relations: The blastoderm is a disc of cells; its upper layer is epithelioid, its lower layers consists of rounded cells more or less irregularly disposed; at its edge it merges into the yolk which continues to produce cells; between the blastoderm and the yolk is a fissure—the segmentation cavity; the yolk under the fissure contains a few nuclei, which have each a little protoplasm about them, but do not form parts of discrete cells.

In reptiles, the process of segmentation is very similar to that in birds. Our knowledge is based principally upon observations upon the eggs of the European lizards (*Lacerta agilis* and *viridis*) which have been studied by Kupffer and Benecke,

30, Balfour, **2,** Sarasin, **41,** Weldon, **49,** and Hofmann Archives ne'erlandaises xvi, 1881) Hofmann gives a resumé) in Broun's Thierreich vi. Abth. iii. p. 1877-1881. The process is more irregular, and small cells are budded off singly and in scattered clusters from the larger segments. At the close of segmentation the germinal disc is converted into a membrane consisting of several layers of cells and parted from the underlying yolk by a thin space—the segmentation cavity; at its edge this membrane, the primitive blastoderm, is united with the yolk, it being immediately surrounded by a segmentating zone, from which it receives accretions. The layer of the yolk immediately under the segmentation cavity contains scattered nuclei, lying singly or in clusters; each nucleus is surrounded by protoplasm; the nuclei are not all alike; some are very large round with very distinct nuclear threads; others are small and often bizarre in shape; probably the latter are budded off from the former.

In Elasmobranchs, the germinal disc is thicker, and consequently the mass of cells resulting from its segmentation cuts in quite deeply into the yolk, Balfour, Comp. Embryol. i, fig. 46, Rückert, **40,** 28. As segmentation progresses, the cells spread out into a layer, which shows the same essential relations as have been described in birds and reptiles. There is the several-layered primitive blastoderm with its edges connected with the yolk and itself overlying the segmentation cavity, the lower floor of which is formed by the multinucleate yolk the representative of the cellular yolk mass of the frog (Fig. 4, *Yolk*). The nuclei are confined to the layer immediately under the segmentation cavity, and this layer corresponds to the sub-germinal plate in teleost ova. Of the yolk-nuclei some are large, others are small as in reptiles; they are the *Parablast-kerne* of His, the *Merocyten-kerne* of Rückert.

In bony fishes, also, we find the same type, but modified somewhat. The process of segmentation has been very carefully studied by C. O. Whitman, **1,** to whom I am indebted for the accompanying semi-diagrammatic figure of the segmented ovum of a flounder. The ovum is surrounded by a vitelline membrane, *z*, from which it has slightly withdrawn,

notably at the upper pole, where lies the thick cap of cells constituting the blastoderm, *Bl.*; in the stage represented, the outer layer of cells is just beginning to assume an epithelioid character; underneath the blastoderm is the well-marked segmentation cavity, *s. c.*; everywhere at the edge of the blastoderm lies the segmenting zone, *k. w.*, a ring of granular protoplasm with rapidly dividing nuclei; the cells resulting from these divisions are added to the edge of the blastoderm, which thus enlarges peripherally. The protoplasm of the segmenting zone is prolonged inwards forming the floor of the segmentation cavity; this sheet of protoplasm *s. g.*, is known as the *sub-germinal plate*. The segmenting zone is, of course, the homologue of the similar zone in amniote ova, or the so-called germinal wall, but it is quite sharply defined against the yolk and therein differs from the wall in the chick, because in the latter the germinal merges gradually into the yolk. The process of segmentation differs from that in elasmobranchs and sauropsida, in that the cleavage of the germinal disc is strikingly regular, and further in that the whole width and thickness of the germinal disc is involved in the segmentation from the very start. The segmentation in teleosts is further interesting as affording proof that all the nuclei as shown by Whitman's investigations, arise from the segmentation nucleus.

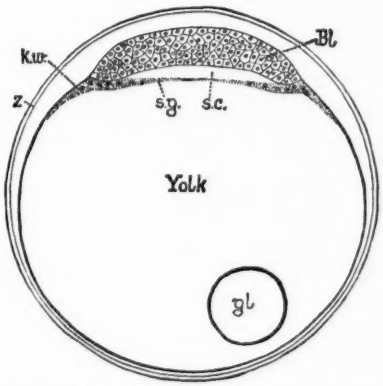


Fig. 6. Ovum of a flounder in transverse vertical section; semi-diagrammatic figure by Dr. C. O. Whitman. *z.* vitelline membrane (or zona); *k.w.* segmenting zone (keim wall); *Bl.* blastoderm or primitive ectoderm; *s. c.* segmentation cavity; *s. g.* sub-germinal plate, *gl.* oil globule of yolk.

To summarize: In vertebrate ova with a large yolk which does not divide into cells until segmentation is considerably advanced, the substance of the animal pole segments com-

pletely and produces several layers of cells (the uppermost becoming epithelioid), which are the ectoderm or primitive blastoderm ; the edge of the blastoderm touches the yolk and is surrounded by a nucleated zone in which the production of cells is continuing ; underneath the blastoderm is the fissure-like segmentation cavity ; the floor of this cavity is formed by the unsegmentated yolk (entoderm) which is furnished with scattered nuclei in the layer immediately under the segmentation cavity ; the yolk nuclei, at least in selachians and reptiles, are of two kinds, very large ones and smaller ones, which arise, probably, from the large nuclei ; the nucleated layer may be termed the sub-germinal plate.

Modified segmentation of placental mammals. The lowest mammals resemble the reptiles in many respects ; amongst other reptilian characteristics of the monotremes, we find ova of large size and rich in deutoplasm. That these ova segment during their passage through the oviduct, in similar manner to those of reptiles, was first ascertained by direct observation by Caldwell in 1884, **16.**

In marsupials and the placental mammalia the amount of yolk substance is greatly reduced and the ovum is of small size. It is, therefore, holoblastic, that is to say, the cleavage planes cut through the entire cell, as in the primitive type of segmentation, but the arrangement of the cells at the close of segmentation appears to be a direct inheritance from the reptilian ancestors of the mammals.

The segmentation of the mammalian ovum was first clearly recognized by Bischoff, though it had been previously seen and misinterpreted by Barry, **5, 6, 7;** very beautiful figures of segmentation in the rabbit have been given by Coste, **17.** More recently, observations have been published by Hensen on the rabbit, **24,** van Beneden on the rab-

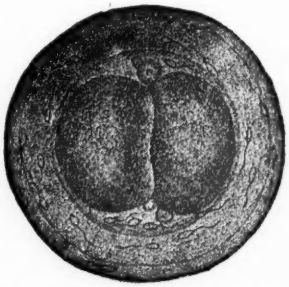
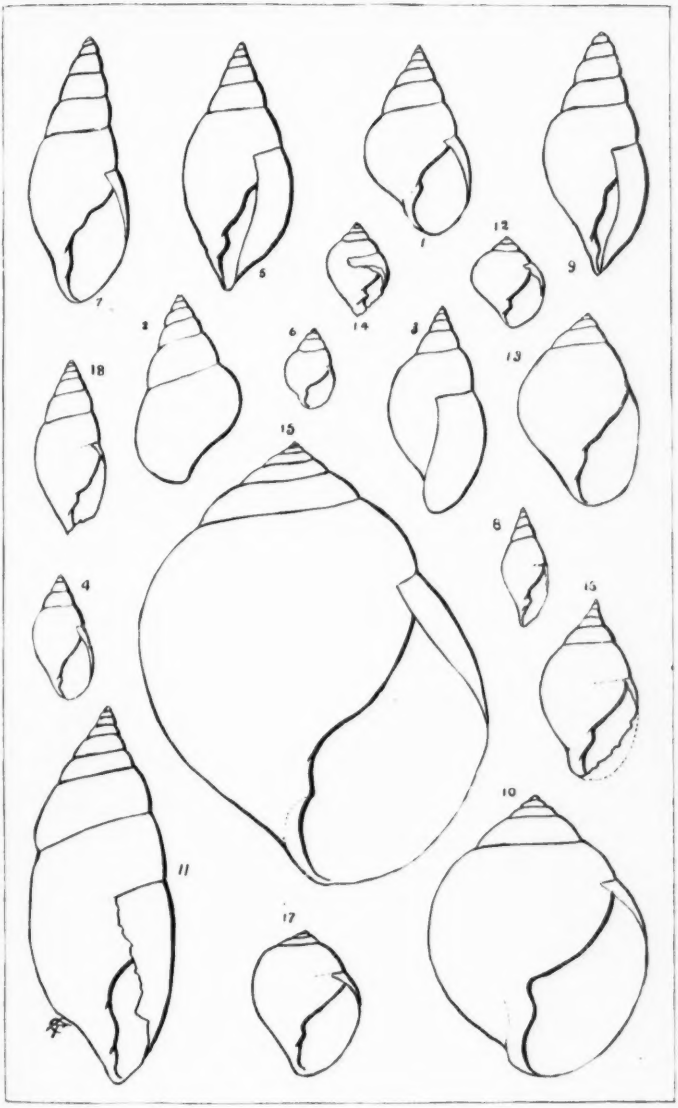


Fig 7. Ovum of a rabbit of twenty-four hours; after Coste. The first cleavage has been completed; the two cells are appressed; above the cells lie the polar globules; numerous spermatoza lie in and within the zona pellucida.

PLATE XX.



Soleniscus.

bit, **8, 9, 10,** Kupffer on rodents, **29,** Selenka on rodents, **44, 45, 46,** and oppossums, **47,** van Beneden and Julin on bats, **13,** Heape on moles, **23,** Tafani on white mice, **48.**

The ovum, when discharged from the ovary, is surrounded by the corona radiata, which is lost when impregnation takes place. Segmentation begins when the ovum is one-half to two-thirds of the way through the oviduct. The ovum spends about 70 hours in the oviduct in the rabbit, and about eight days in the dog. The first cleavage plane passes through the axis of the ovum which is marked by the polar globules. When first formed, the two segmentation spheres are oval and entirely separated from one another, but subsequently they flatten against one another and become appressed—a remarkable phenomenon of which we possess no explanation whatever. The second cleavage plane is also meridional.

The ovum next divides into eight and then into twelve segments, of which four are larger than the rest.

The succeeding cleavages have never been followed accurately, but from Heape's observations on the mole, **23,** 166, we know that the divisions progress with great irregularity, and is probable that the commonly assumed regularity of mammalian segmentation does not exist in nature. After a time (in the rabbit about 70 hours) there is reached the stage termed *Metagastrula* by van Beneden, **10,** 153-160, in accordance with his view of the homologies of this stage. The metagastrula consists of a single layer of cuboidal hyaline cells lying close against the zona pellucida (Fig. 8) *en;* the space within this layer contains an inner

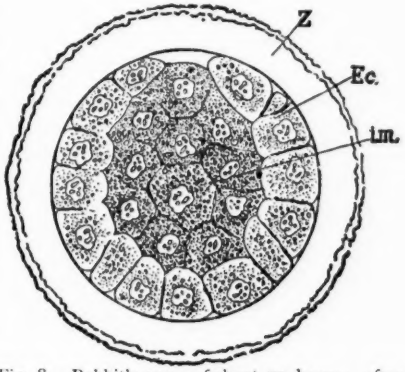


Fig. 8. Rabbit's ovum of about 70 hours; after E. van Beneden. *z.* Zona pellucida; *en.* entoderm; *i. m.* inner mass of granular cells.

mass of cells, *im*, which are rounded or polyzonal and densely granular. At one point the outer layer is interrupted and the space is filled by *one* of the granular segments of the inner mass (Fig. 8). The nuclei of all the cells are somewhat nodulated, and have several highly refractible granules each. The granules in the bodies of the cells of the outer layer are somewhat concentrated around the nucleus, leaving the cortices of the cells clear, van Beneden, **9**, 28-29, has observed that sometimes (21 oval out of 29) the first two segmentation spheres are of unequal size in the rabbit, and similar variability occurs in the mloe, Heape, **23**, 165 ; Tafani, on the other hand, expressly denies its occurence in white mice. It is, I think, very improbable that this difference, which sometimes occurs and sometimes does not, has any fundamental significance ; van Beneden, however, has maintained that the small cell gives rise in the rabbit to the inner mass of cells, (see below) which he terms the entoderm, but which must, it seem to me, be homologized with the ectoderm, as explained below. That van Beneden is in error, as to the genetic relation of the small cell to the inner mass has been demonstrated by Heape, **23**, 166.

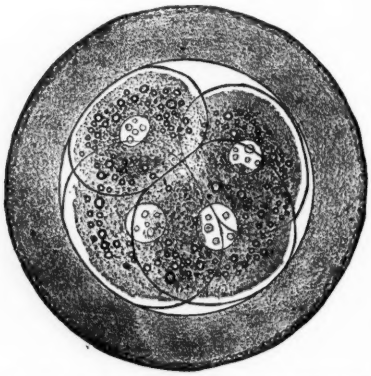


Fig. 9. Ovum of a bat, Vespertilio murina, with four segmentation spheres; after van Beneden and Julin.

The second cleavage plane is probably also meridional, and is certainly at right angles to the first, so that four similar cells are produced as in the primitive type of segmentation,[1] (Fig. 9) those four cells are also rounded at first, and probably become fitted against one another so as to produce the

[1] The distinction here made between "primitive type of segmentation" an "primitive type of *vertebrate* segmentation" should be borne in mind by the reader.

disposition observed by Tafani 1889, **48**, 116, in mice ova at this stage; Tafani describes each cell as having the form of a three-sided pyramid with the apex at the centre of the ovum and a convex base forming part of the external surface of the yolk. That the two first cleavage planes are meridional is rendered probable by the arrangement in the four cell stage observed by Selenka in the Virginian oppossum. (Fig. 10.)

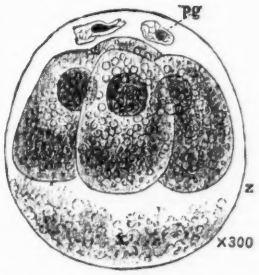


Fig. 10. Ovum of Virginian oppossum with four segments; after Selenka.

(To be continued.)

THE SONG OF THE SINGING MOUSE.

BY. WM. T. DAVIS.

IN the daily papers and in scientific journals references to singing mice are not uncommon, some relating to wild species, but generally to the house mouse. The authors of these notices usually refer to the mice as singing from happy choice, as if they greatly enjoyed their own music, and in captivity, they have been reported as singing when food was given them, or when turning the wheel, as expressive of delight and high spirits. In some cases a mouse may be able to sing at will, but I think, from the descriptions I have read, that it is generally involuntary, as it certainly was in the individual that came under my own observation.

Several years ago, in November, I heard a strange noise near some water pipes in a store room, and at first thought that one of them had broken, and that a little stream was gurgling between the walls. However, later on, this gurgling noise was found to be produced by a mouse, which ran from behind various boxes as they were, in turn, removed, keeping up a constant song. A trap was set, and after a few days the mouse was captured. In the meantime, it was heard at inter-

vals, from cellar to garret, as this tell-tale song gave notice of its wanderings.

When removing it from the trap to the cage, and many times afterward, it ran about a small room, and the most noticeable feature on these occasions was the unvaried song, it being especially loud if I caused the mouse to scamper around the room several times without stopping. When gnawing on the exposed wood in the cage, when eating, or when disturbed in its nest, this singing was also particularly loud; in fact, upon any exertion, the song was produced, varying in volume in proportion to the amount of exercise.

On Thanksgiving day, eleven days after her capture, my mouse had two young, poor, miserable, little creatures, but, nevertheless, able to squeak and make considerable noise. It was just previous to, and for some time after the birth of these young, that *Mus* sang most continuously.

The young grew apace, and on December 14th, one was looking out of the nest, while the mother kept up a constant singing, probably being much excited thereby. At this stage the baby mice were funny little bodies, sparsely covered with hair and the dimensions of a respectable peanut. On the 19th, both of the young mice were out of the nest, and one was quite helpless, laying on his back kicking and panting after he had tumbled about the cage. I was afraid he would be unable to get into the nest again, so I rendered some assistance. However, in about fifteen minutes he was out as before, tumbling about in just the same rough manner, the mother all the while keeping up a constant singing, and alternately running in and out of the nest. After a time she picked up the little mouse by the side of the neck, carried it across the cage and put it in the nest, and I did not see it again. The other baby mouse was quite able to care for itself.

On December 21st the mother mouse ate about half of one of her offspring, commencing at the head. The one devoured was the most backward of the two, and I found the lively fellow, on this occasion, at the other end of the cage, the most distant point from his mother. I have had a full-grown *Hes-*

peromys mouse eat a large portion of one of the same species, though there was plenty of food in the cage at the time; and, as with this *Mus*, it started its cannibalistic operations with the head of its companion.

These two mice were not very good specimens as mice go. The mother was small and thin and her offspring, at first, equally miserable in appearance; but an abundant food supply finally bettered their condition. Fourteen more young, divided into four litters, were born to this musical rodent in the course of the year and seven months of her captivity, and the incidents detailed in the account of the first were repeated with slight variations. One morning it was discovered that the singer had devoured her spouse, though, be it said in her favor, he may have died first. The family was thus broken up, and the probable cause, in consequence, transferred to a bottle of alcohol, where she at present remains.

As I have said, it was the time at which the mouse was the weakest, when made to exercise greatly and breath fast, that the singing was chiefly noticeable, and I think a few quotations from some other notes on the subject will tend in the same direction. Mr. Wm. H. Edwards, in the AMERICAN NATURALIST, Vol. III., p. 551, says: "The captive seemed pleased with his quarters, and soon manifested his content at the quality and regularity of his rations by singing his unvarying tune at all hours." When ejected from his bed "he would manifest his displeasure by flying across the cage into the wheel, which he would make spin, emitting all the while his peculiar note with great shrillness and rapidity."

The Rev. Samuel Lockwood, in his note on "A Singing Hesperomys," printed in the AMERICAN NATURALIST, says: "A very noticeable fact was that a great deal of the little creature's song was poured forth while at play—that is, while in actual activity, and take the wheel-play, for instance, when really in quite violent exercise. A thing, too, which much surprised me was that often when eating she sang and eat at the same time, literally in the same breath." Mr. Lockwood thought that this last might be suggestive of a physiological

difficulty, but he nevertheless gives reasons, under four heads, to disprove the disease theory, and says in the fourth that "she can sing and eat at the same time."

From the facts given above it will be observed how the circumstances under which these mice sang agreed: when ejected from bed, when eating or gnawing, and, as I have shown, when forced to run rapidly about a room, in which act there could be no pleasure. Neither was it happy feelings that prompted the song when I meddled with her babies, when she cowered at the other end of the cage, evincing all the anxiety that is usually shown by animals under such circumstances. In birds we know the cause of song for rivalry or for pleasure, but we always hear quite other notes than those expressive of pleasure, when we look at their precious eggs.

EDITOR'S TABLE.

EDITORS: E. D. COPE AND J. S. KINGSLEY.

As suggestions looking to the adoption of some flower as emblematic of our country are now being made, we present some opinions on the topic. The conditions to be satisfied are: 1st, that the flower shall be conspicuous; 2d, that it shall be available for architectural carving; and 3d, that it shall be characteristically American. These conditions exclude many plants that have been named. Propositions in favor of introduced plants, such as the Convolvulus, are out of the question. Members of the Compositæ are mostly undistinguishable in sculpture, and such forms as the golden-rod, which has met with much favor, are unavailable for architecture. The mountain laurel (Rhododendron), is objectionable, since the genus is widely distributed in other regions; and the same objection holds true of the Magnolias. The Indian Corn and the Sweet Gum (Liquidambar) are both destitute of conspicuous flowers. We wish to call attention to two species which satisfy all the conditions. These are the *Kalmia latifolia* ("laurel"), and the *Liriodendron tulipifera* ("tulip-tree"). Both are of wide distribution; both are conspicuous in various

ways, and both belong to genera exclusively North American. Both lend themselves well to the sculptor's art. Between them there is little choice, but we rather lean to the tulip-tree, which, besides its conspicuous flowers and very characteristic leaves, is one of the monarchs of our woods. It thus well represents our characteristic richness in forests, and expresses, figuratively, the strength and greatness of our country.

The scientific editor of the *New York Tribune* will be probably on hand at the Toronto meeting of the American Association for the Advancement of Science, to misrepresent the science of the United States. According to this luminary, the only important scientific meeting held in America up to 1884, was that of the British Association at Montreal that year. As Toronto is not on American soil, he will probably find this year's meeting the next most important. The left-handed compliments paid by this gentlemen to American science will, perhaps, suggest to the readers of his articles that the mind of their author acts inversely as the square of the distance of its objects. We wish we could find an integration of the matter of these articles at all correspondent to the dissipation of energy wasted in writing them.

RECENT LITERATURE.

SCUDDER'S MESOZOIC COCKROACHES.[1]—On comparing mesozoic with palæozoic cockroaches the author finds the fundamental distinction is in the change which the principal nervures of the upper wings have undergone, by the basal or total amalgamation of some of them—a change which reaches its culmination in living species. In the basis of these differences he divides the mesozoic cockroaches into three groups: *a*, those in which only the mediastinal and scapular veins are amalgamated; *b*, those in which the externomedian is united with one of the veins on either side of it; *c*, those in which either

[1] A Review of Mesozoic Cockroaches. By Samuel H. Scudder. Extract from the Memoirs of the Boston Society of Natural History. 1886.

the mediastinal, scapular, and externomedian veins are all united, or there are two lines of union, one between the mediastinal and scapular, and the other between the externomedian and internomedian veins. There are fifty species (28 sp. nov.) figured and described in detail. These are referred to seventeen species, four of which are new.

LYDEKKER'S FAUNA OF THE KARNUL CAVES.[1]—This quarto, of 57 pages and 5 plates, belongs to the series of Palæontologia Indica. The author describes remains of 42 mammals, 8 birds, 5 reptiles, 1 toad, and 9 mollusks. Of the larger mammals no complete skulls were found; only detached teeth, fragments of jaws, and more or less imperfect limb bones. Of the smaller mammals skulls were found in some instances. The remarkable feature in the mammalian remains is the occurrence of a *Cynocephalus*, which may be identical with a living African species; of *Hyæna crocuta*; of a small equus, indistinguishable from *E. asinus*; and of a *Manis*, apparently identical with the existing West African species, *M. gigantea*. The author considers the occurrence of these forms extremely important in supplementing the evidence afforded by the Siwalik fauna as to the probable derivation of many of the existing Ethiopian mammals from those of the later tertiaries of India.

BRANNER'S CRETACEOUS AND TERTIARY GEOLOGY OF THE SERGIPE-ALAGÔAS BASIN OF BRAZIL.[2]—The author states that the importance of this region is due to (1) The representation of a geological range unusual in Brazil: (2) The rich fossiliferous nature of many of its beds; (3) The accessibility of good exposure across the entire section. He is of the opinion that the key to future successful geologic work in Brazil lies in the careful study and comprehension of some such typical region as that comprised in the provinces of Sergipe and Alagôas. Although much of this paper is of a statistical nature, it will be found extremely interesting by the general reader as well as by the special student.

[1] The Fauna of the Karnul Caves. By R. Lydekker, B. A., F. G. S., etc. Extract Memoirs of the Geol. Survey of India, Vol. IV., Part II. 1886.

[2] The Cretaceous and Tertiary Geology of the Sergipe-Alagôas Basin of Brazil. By John C. Branner, Ph. D. Extract from Trans. Am. Philosoph. Soc., Vol. XVI., 1889.

HULL'S GEOLOGICAL AGE OF THE NORTH ATLANTIC OCEAN.[1]—A quarto of 12 pages illustrated by 3 sketch maps and several sectional drawings. The author opposes the doctrine of the permanency of oceans and continents, held by Dana, Le Conte and Dr. Wallace, and cites facts derived from observations in the region of the North Atlantic to uphold Lyell's views of the repeated interchange of oceans and continents. He refers the date of the oceanic condition of the Atlantic area, and of the continental conditions of Eastern America and Western Europe to the close of the Palæozoic epoch.

BOULENGER'S REPTILES AND BATRACHIANS OF THE SOLOMON ISLANDS.[2]—The position of this group of islands, on the limits of two great zoological districts, renders the study of its fauna of special interest, as it is the point where many of the Papuasian and Polynesian forms intermingle. The author gives a list of all the species hitherto found in the Solomon group, with notes on the general habitats. It includes nineteen reptiles and nine batrachians, some of which are restricted to these islands. The plates are admirable in every respect; the drawing is spirited, most of the batrachians especially so. The most remarkable discovery recorded is that of the genus Ceratobatrachus Boul, a form which represents in the Firmisternial Salientia the Hemiphractus of the Arciferous line. The parallel is shown in the mandibular teeth and the huge dermo-ossification of the head. This discovery nearly completes the parallels between the Arcifera and the Firmisternia.

BENNETT AND MURRAY'S CRYPTOGAMIC BOTANY.[3]—As stated in the Introduction, "No general hand-book of cryptogamic botany has appeared in the English language since the Rev. M. J. Berkley's in 1857." In this period, almost one-third of a century, since the preparation of that famous and

[1] On the Geological Age of the North Atlantic Ocean. By Edward Hull, LL D., F.R.S., F.G.S., Director of the Geol. Sur. of Ireland. Extract from the Scientific Trans. Roy. Dublin Soc., Vol. III., 1885.

[2] On the Reptiles and Batrachians of the Solomon Islands. By G. A. Boulenger, F.Z.S. Extract from Trans. Zool. Soc., Vol. XII., 1886.

[3] *A Handbook of Cryptogamic Botany*. By Alfred W. Bennett, M.A., B.Sc., F.L.S., Lecturer on Botany at St. Thomas' Hospital; and George Murray, F.L.S., Senior Assistant, Department of Botany, British Museum, and Examiner in Botany, Glasgow University. With 378 Illustrations. London: Longmans, Guerny and Co.; and New York: 15 East 16th Street. 1889. All rights reserved. 12mo, pp. viii., 473.

useful book, cryptogamic botany "has gone through little less than a revolution." The present work is an attempt to bring within reach of botanists an acquaintance with the present state of our knowledge of this branch of science. How fully the authors have succeeded trial alone will tell. That they have made a useful book is evident at a mere glance.

The general plan of the work may be made out from the following general subdivisions of the subject, which correspond to unnumbered chapters in the book, viz.: Vascular Cryptogamia; Muscineæ; Characeæ; Algæ; Fungi; Mycetozoa; Protophyta. As will be seen, the work begins with the higher forms and passes to the lower, a plan defended by the authors by the statement that "to the general student 'from the known to the unknown' is a very sound principle." They say, however, that, "had our purpose been to construct, theoretically, a genealogical tree for the lower forms of vegetable life, the former course (commencing at the bottom) must necessarily have been pursued, and in the labor in favor of proceeding from the simple to the more complicated types." From which one would infer that this book is useful only to the general student. It will, on the contrary, prove a useful handbook for the laboratory student, in spite of its erroneous plan. Had our authors commenced with the lower plants, and worked up from them, they would have made their book still more useful, not only to the scientific student, but in according to our observation, to the "general student" as well.

Again, it is seen that there is here a partial "reversion to the time-honored division" of the lower plants, whereby the Algæ and the Fungi are recognized as natural groups. It is only a partial reversion, however, and botanists of the old school will scarcely recognize in the modern groups, the older ones of the same names. The Algæ suffer the loss of the Characeæ, the Protococcoideæ, the Diatomaceæ, and the Cyanophyceæ, while the Fungi lose the Myxomycetes, the Acvasieæ, and the Schizomycetes, and are augmented by having swallowed bodily the whole of the Lichens.

A feature of the work, which is to be especially commended, is the very general Anglicizing of terms; *e. g. sporange* for *sporangium; archegone* for *archegonium; antherid* for *antheridium*, etc., etc.

The amount of space assigned to each group is as follows: Vascular Cryptogamy, 122; Muscineæ, 40; Algæ (in the widest sense), 174; Fungi (in the widest sense), 110. Berke-

ley's proportions were better; he gave to each of his groups space as follows: Filicales, 58 pages; Muscales, 77; Fungales, 185; Algales, 156. It may be remarked also that Berkeley's order is the reverse of that adopted in the book under consideration.

There are many points which might be critically discussed in this book; naturally so, because its enforced brevity compels a summary treatment, in which the names of things are not fully given. But we have sufficiently indicated the general character of the work, which will unquestionably be very useful.—*Charles E. Bessey.*

BASTIN'S BOTANY.[1]—This book is a revised and enlarged edition of Professor Bastin's "Elements of Botany," which appeared a couple of years ago. The enlargement has greatly improved what was a good book to start with, and in the volume before us we have a nicely gotten up and useful work. Following in part the older ideas, toward which there is now an evident return among botanists, the author devotes thirteen chapters to Organography, which is, in fact, the organography of the flowering plants alone. The student will be likely (unless corrected by his teacher) to get somewhat warped notions as to the vegetative organs, and the organs of reproduction in the vegetable kingdom, from these 120 pages of introductory matter.

Then follow three chapters (aggregating about 100 pages) devoted to vegetable histology, in which the cell, plant tissues, and tissue systems are discussed. About 40 pages of Vegetable Physiology follow, and the remainder of the book is taken up with a brief survey of the vegetable kingdom, from the Myxomycetes to the Spermaphytes, and two brief chapters on the succession of vegetable life. There is also a glossary of about 30 pages, and a full index.—*Charles E. Bessey.*

DYER'S FOLK-LORE OF PLANTS.[2]—This is not a botanical book, unless we interpret liberally that very liberal definition of botany which declares it to include "every inquiry about

[1] *College Botany*, including Organography, Vegetable Histology, Vegetable Physiology, and Vegetable Taxonomy, with a brief account of the Succession of Plants in Geologic Time, and a glossary of Botanical Leaves. By Edson S. Bastin, A.M., F.R.M.S., Professor of Botany, Materia Medica and Microscopy in the Chicago College of Pharmacy. Chicago: G. P. Engelhard & Co., 1889. 8vo, pp. xvi. 451, with 579 Figures in the text.

[2] *The Folk-Lore of Plants.* By T. F. Thiselton Dyer. New York: D. Appleton & Company. 1889. 12mo, 328 pp.

every plant." The book before us is written in twenty-three chapters, devoted to such topics as Plant Worship, Plants in Witchcraft, Plants in Fairy-Lore, Love-Charms, Dream-Plants, Plant Language, Plants and their Legendery History, etc., etc. A few titles have a faint botanical color, as: Plants and the Weather, Plant Names, and Plants in Folk-Medicine, but it is very faint, indeed. Under the first, which certainly admits of at least a semi-scientific treatment, we have such rhymes as

> "Sow peas and beans in the wane of the moon.
> Who soweth them earlier, he soweth too soon.
> That they with the plant may rest and rise,
> And flourish with bearing, most plentiful wise."

And

> "Many haws
> Many snaws."

And again:

> "When the aspen leaves are no bigger than our nail,
> Is the time to look out for truff and peel."

In the chapter on plant names the treatment is better, but in that on Folk-Medicine we drop into poetry again, *e. g.*:

> "Eat an apple going to bed,
> Make the doctor beg his bread."

And

> "The fair maid who, the first of May,
> Goes to the fields at break of day,
> And washes in dew from the hawthorn tree.
> Will ever after handsome be."

Now, although this is not a botanical book, and while to a botanist many of its pages seem trash, yet for those for whom it was written the work is well done, and will be welcomed by many a reader.—*Charles E. Bessey.*

GEOLOGY AND PALÆONTOLOGY.

MARSH ON CRETACEOUS MAMMALIA.[1]—Professor O. C. Marsh has been successful in obtaining the teeth and bones of a number of species additional to the *Meniscoëssus conquistus* Cope, discovered by Wortman in 1882. The remains described have been found separate and fragmentary, and they indicate several species of small size belonging to the Multituberculata

[1] Discovery of Cretaceous Mammalia. By O. C. Marsh. *Amer. Journal Sci. Arts*, July and August Nos., 1889, pp. 81-177.

and to the Bunotheria. The former are typical members of the order, while though it is at yet difficult to locate the latter with certainty, they display no dental characters not found in the Creodonta. No Condylarthra have been as yet obtained, a fact which so far indicates the distinction between the faunæ of the Laramie and Puerco epochs. Apart from this, the fossils strongly resemble those of the Puerco, and detract nothing from the supposition which I have entertained that the latter fauna belongs to the Mesozoic series. It is needless to say that the position which I assumed in 1869, that the Laramie belongs to the Cretaceous system, and is not Cænozoic, is fully sustained.

The manner in which Professor Marsh has done this work requires notice. The most superficial knowledge of the subject would have shown him that the molar teeth which he has described as representing distinct genera belong mostly to different parts of the series of the same genus, and often species, and not unlikely, individuals. Thus, supposing superior anterior molars to be regarded as typical, we have the posterior and inferior molars, and even the premolars of the same genus described under separate generic names. In his first contribution nine generic names may be, with the greatest probability, referred to two genera. One of these is the genus Meniscoëssus, known since 1882, and the other is not shown to be distinct from Chirox or Polymastodon of the Puerco fauna. Of Bunotheria the three genera are proposed on teeth from different positions in the jaws of forms which may well belong to one genus, and no evidence is brought forward to show how they differ generically from the smaller species of Sarcothraustes of the Puerco. This is not the way to advance science.

Professor Marsh states that the genus Meniscoëssus was described from a tooth which he supposes to belong to a reptile. The fact is that was founded on the molar tooth of the mammal to which Professor Marsh now gives, among others, the name Selenacodon. (See AMERICAN NATURALIST, 1882, p. 830.)—*E. D. Cope.*

NOTES ON THE ORIGIN AND HISTORY OF THE GREAT LAKES OF NORTH AMERICA.[1]—*Discovery of the ancient course of the St. Lawrence River.* Previous investigations by the author showed that there was a former river draining the Erie basin and flowing into the extreme western end of Lake On-

[1] Abstract from the Proceedings of the American Association for the Advancement of Science, vol. xxxvii.

tario, and thence to the east of Oswego, but no further traceable, as the lake bottom rose to the northeast. Upon the southern side there was a series of escarpments (some now submerged), with vertical cliffs facing the old channel. By recent studies of the elevated beaches, it is demonstrated that the disappearance of this valley is due to subsequent warpings of the earth's crust, and that the valley of the St. Lawrence was one with that of Lake Ontario. Recent discoveries of a deep channel upon the northern side of Lake Ontario (a few miles east of Toronto), and of the absence of rocks to a great depth under the drift, far beneath the surface of Lake Huron, between Lake Ontario and the Georgian Bay—and in front of the Niagara escarpment, between these lakes—of a channel in Georgia Bay, at the foot of the escarpment, and of the channel across Lake Huron, also at the foot of a high submerged escarpment, show that the ancient St. Lawrence, during a period of high continental elevation, rose in Lake Michigan, flowed across Lake Huron, and down Georgian Bay and a channel, now filled with drift, to Lake Ontario ; thence by the present St. Lawrence valley to the sea, receiving on its way the ancient drainage of the Erie basin and other valleys.

Origin of the basins of the Great Lakes. The two questions involved are the "origin of the valleys" and the "cause of their being closed into water basins." The basins of Lakes Ontario and Huron are taken for consideration. The previous paper, upon the course of the ancient St. Lawrence, shows that the Huron and Ontario basins are sections of the former great St. Lawrence valley, which was bounded, especially upon the southern side, by high and precipitous escarpments, some of which are submerged. Upon its northern side there were lesser vertical escarpments, now submerged, with walls facing the old valley. The valley was excavated when the continent was at a high altitude, for the eastern portion stood at least 1,200 feet higher than at present, as shown by the channels in the Lower St. Lawrence, in Hudson's Straits, and off the New York and Chesapeake Bays. The valley was obstructed in part by drift and in part by a north and northeastward differential elevation of the earth's surface, due to terrestrial movements. The measurable amount of warping defied investigation until recently, but it is now measured by the uplift of the beaches and sea cliffs. Only one other explanation of the origin of the basins need be considered—that of the "Erosion by Glaciers," (*a*) because the lake basins occur in glaciated regions ; (*b*) glaciers are considered (by some) to erode ; (*c*) supposed necessity, as the terrestrial warping was not known.

In reply: Living glaciers abrade but do not erode hard rocks, and both modern and extinct glaciers are known to have flowed over even loose moraines and gravels. Again, even although glaciers were capable of great plowing action, they did not affect the lake valleys, as the glaciation of the surface rocks shows the movement to have been at angles (from 15° to 90°) to the trend of the vertical escarpments against which the movement occurred. Also, the vertical faces of the escarpments are not smoothed off, as are the faces of the Alpine valleys down which the glaciers have passed. Lastly, the warping of the earth's surface in the lake region since the beach episode, after the deposit of the drift proper, is nearly enough to account for all rocky barriers which obstruct the old valley and form lake basins.

Establishment and dismemberment of Lake Warren. This is the first chapter in the history of the Great Lakes, and is subsequent to the deposit of the upper boulder clay, and therefore the lakes are all very new in point of geological time. By the warping movements of the earth's crust, as shown in the beaches—after the deposit of the later boulder clay—the lake region was reduced to sea level,and there were no Canadian highlands northward of the Great Lakes. During the subsequent elevations of the continent beaches were made around the rising islands. Thus, between Lakes Erie, Huron and Ontario a true beach was formed at 1,690 feet above the sea around a small island rising 30 feet higher. With the rising of the continent, Lake (or perhaps Gulf of) Warren—a name given to the sheet of water covering the basin of all the Great Lakes—was formed. A succession of beaches of this lake have been worked out in Canada, and from Lake Michigan to New York, extending over many hundreds—almost thousands—of miles. Everywhere the differential uplift has increased from almost zero, about the western end of the Erie basin, to three, five, and, in the higher beaches, more feet per mile. With the successive elevations of the land this lake became dismembered, as described in the succeeding papers, and the present lakes had their birth. The idea that these beaches in Ohio and Michigan were held in by glacial dams to the northward is disproven by the occurrence of open water and beaches to the north, which belong to the same series, and by the fact that outlets existed where glacial dams would be required.

Discovery of the outlet of Huron-Michigan-Superior Lake into Lake Ontario, by the Trent Valley. With the continental elevation described in the last paper—owing to the land rising more rapidly to the northeast—Lake Warren became

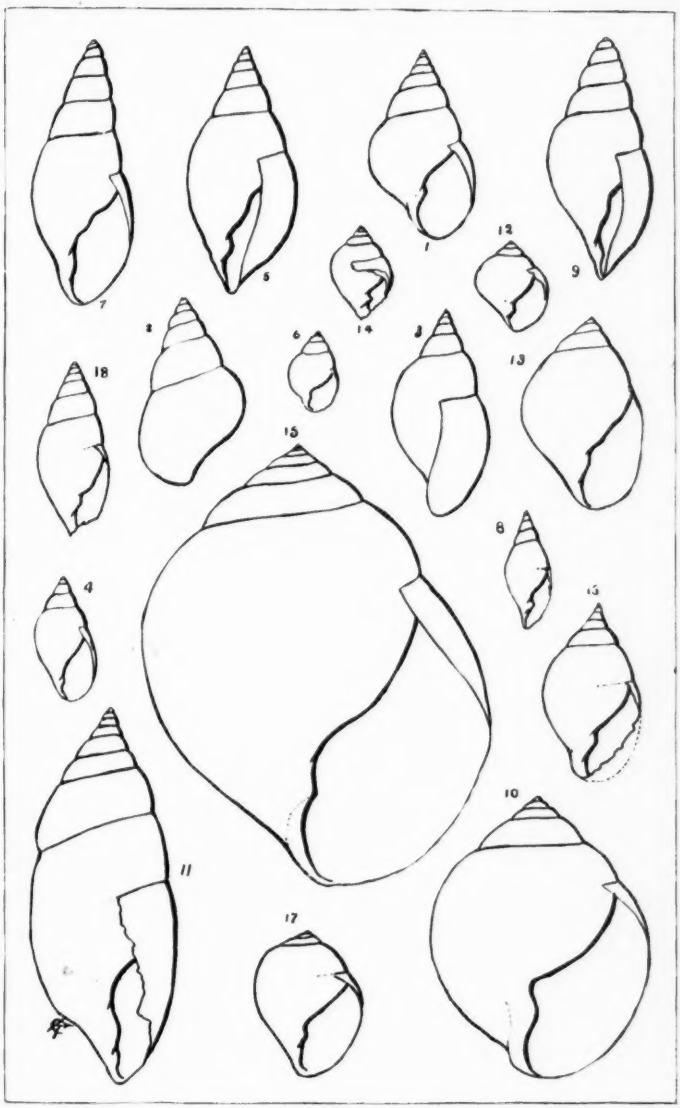
dismembered, and Huron, Michigan and Superior formed one lake ; the Erie basin was lifted out of the bed of Lake Warren and became drained, and Ontario remained a lake at a lower level. The outlet of the upper lake was southeast of Georgian Bay by way of the Trent valley into Lake Ontario, at about sixty miles west of the present outlet of this lake. The outlet of this upper lake was 26 feet deep where it connected with the Trent valley, and the channel was from one to two miles wide. This, for a few miles, is cut across a drift ridge to a depth of 500 feet. With the continued continental uplift to the northeast (which has raised the old beach at the outlet into the Trent valley, about 300 feet above the present surface of Lake Huron), the waters were backed southward and overflowed into the Erie basin, thus making the Erie outlet of the upper lakes to be of recent date. This is proven by the fact that the beach which marked the old surface plain of the upper Great Lake descends to the present water level at the southern end of Lake Huron.

Erie the youngest of all the Great Lakes. The Erie basin is very shallow, and upon the dismemberment of Lake Warren was drained by the newly constructed Niagara River (except, perhaps, a small lakelet southeast of Long Point). Subsequently the northeastward warping (very much less in amount than farther northward at the Trent outlet) eventually lifted up a rocky barrier and formed Erie into a lake in recent times, thus making Erie the youngest of all the lakes. The beaches about Cleveland are not those of separated Lake Erie, but belong to the older and original Lake Warren.

[NOTE.—To distinguish from the modern, the ancient valley of the St. Lawrence, above described, is named the "Laurentian," the ancient river from the Erie basin the Erigan, the Huron-Michigan-Superior Lake the Algonquin, as also the beach which marked its shores and the river which discharged its waters by the Trent valley. The expanded, but separate, Lake Ontario is named the Iroquois, as also its principal beach, now at 116 feet above its modern surface at the extreme western end of the lake, while at about 135 miles northeastward (near Trenton) its elevation is 435 feet.—*J. W. Spencer*, University of Georgia, Athens, Ga.]

KRAKATOA.—A period of five years has not been found too long in which to collect and collate the material necessary for a history of the gigantic eruption of 1883, which has been

PLATE XX.



Soleniscus.

made the subject of elaborate Reports by Dutch, German and English investigators.[1]

These Reports have been recently published and have been ably reviewed in recent issues of the *Contemporary* and *Edinburgh Reviews*.[2]

For a description of the physical characteristics of the great eruption the reader may consult these publications, but the scientific results as detailed in the several Reports may be briefly summarized. The process by which the eruption was brought about is considered to be typical of the physical action of volcanoes all over the world. Sea and surface water obtain access to the vent or to the heated rocks below it, and if brought suddenly into contact may give rise, by the development of steam, to earthquakes or eruptions of moderate strength, but it is to the slow percolation of water into rocks in a certain condition that the author of the English Report attributes the principal part in cataclysmal outbreaks. The water combines with the material of the rock, and by this combination the melting point of the rock is reduced; it only requires the subjection of the hydrated compound to such heat as would be supplied by the anhydrous lavas in a fluid condition to disengage steam and other gases in enormous quanities, and to produce outbursts proportionate to the pressure and the strength of the inclosing walls. If, while this process is going on; water in large quanities gains access to the surface of the heated mass, solidification might take place and the escape of gases through the crater would be temporarily checked. When at last the accumulated force bursts the newly-formed crust, this and other obstacles would be speedily removed by the tremendous violence of the blast, and the sides of the crater might either be blown away or fall into the seething lava. Such appears to have been the working of the final eruption of Krakatoa. The objection that water could not percolate to great depths, owing to the upward pressure of steam, already

[1] Krakatau. Par. M. Berbeck. Publié par ordre de Son Excellence le Gouverneur Général des Indes Néderlandaises. Batavia: 1884 and 1885. Paris; 1885 and 1886.

The Eruption of Krakatoa and Subsequent Phenomena. Report of a Committee appointed by the Royal Society 1888.

Untersuchungen über Dammerungserscheinungen zur Erklärung der nach dem Krakatau-Ausbruch beobachteten atmosphärisch-optischen Störung. Von J. Kiessling. Hamburg and Leipzig: 1888.

[2] *Contemporary Review*, November, 1888. New York; Leonard Scott Publishing Company.

Edinburgh Review, January, 1889. New York; Leonard Scott Publishing Co.

formed, is met by recent experiments which show that the capillary action continues in spite of such pressure.

The presence of volcanic cones and craters on the moon would seem to invalidate the "steam engine" theory as well as the hydrated lava theory of Professor Judd, unless the presence of water in large bodies is admitted, On both the earth and moon the expansion of fluid rock in the process of cooling would bring to bear an enormous pressure, resulting in outwellings of lava, and violent eruptions would be accounted for by the development of steam on a large scale. It is generally admitted that communication exists not unfrequently between reservoirs of molten rock at great distances from each other on lines of fissure. Heated rocks, subjected to the hydration and aeration of infiltrated water would probably occupy more space in a solid than in a pasty or liquid condition, and would melt at a lower temperature. Contraction by cooling of the solidified part of the globe, works in the opposite direction; but while this process is fairly regular and even, solidification may take place unequally, rapidly, and by local causes, such as cooling by extensive aqueous percolation. Other causes of periodic increases of pressure would be the shrinkage of the earth's crust upon the cooling interior, the percolation of water through fissures and the closure of these fissures by changes of level, so that steam developed at some miles below the surface would force the fluid lava through the nearest volcanic vent. As far as the argument from the moon is concerned, it can be readily disposed of by admitting the previous existence of water on its surface, which has been entirely absorbed by the rocky substance.

Among the attendant phenomena of the eruptions were the sea-waves. These caused greater destruction both to property and to human life than any other of the attendant phenomena. They are treated at great length by Captain Wharton in the English Report. Undulations were produced reaching as far as Havre, a distance of 10,780 miles from the original source of disturbance. The seismic flows and ebbs which thus covered a very large part of the globe were composed of long undulations, with periods of over an hour, and of shorter superposed irregular waves at brief intervals. The rate of propagation was in all cases less than theory would demand for the supposed depth of water. The average speed seems to have been something between 330 and 380 miles per hour. The mean depths deduced by the usual formula from this speed are less than those given by actual soundings. The cause of this discrepancy

is not clear; but if the tide gauges can be relied upon, and the disturbances recorded are due to identical original waves, it seems probable that submarine elevations and ridges, hitherto unknown, retard the progress of the disturbance. The period of the long wave was originally about two hours, but at distant stations, such as Orange Bay and the ports of the English Channel, the period seems to have been reduced to about one fourth, and, throughout the course of the undulations, its original character appears to have undergone considerable modification. The cause of an undulation with a period of two hours remains a mystery, but of the correspondence between the water and air waves in point of time at starting there can be no question. An upheaval of the sea bottom must have been very slow to account for the length of the wave; no earthquake was observed, and the evidence generally is against earth disturbance as a cause. It is noted that the bulk of the fragments thrown out during the explosions must have fallen into the sea, and by their impact, almost coinciding with the violent evisceration of the crater, must have contributed to the rush of the destructive waves, and Captain Wharton calculates that a fiftieth part of the missing mass of Krakatoa, which was estimated to be at least 200,000,000,000 cubic feet, would, by dropping suddenly into the water, form a wave circle of 100 miles in circumference, 20 feet high, and 350 feet wide. But this is inadequate to account for the long wave; and he therefore holds that the destructive waves in the Strait of Sunda were mainly due to masses falling into the sea, or to sudden explosions under the sea, but that the long wave recorded by distant tide guages had its origin in upheaval of the bottom.

Another marked accompaniment of the explosion was the air wave. Reports from 47 stations representing the entire civilized world show that an air wave spread out from Krakatoa as a centre expanding in a circular form till half round the globe, concentrated again towards the Antipodes, whence it started afresh and travelled back to Krakatoa, occupying in the double journey 36 hours, rebounded and set off again on the same revolution, and repeated the movement at least three times sufficiently strongly to be recorded. Seven passages, going and returning were indicated by the diagrams at some stations. The whole process was almost exactly similar to the alternate expansions and contractions of a wave of water caused by dropping a stone at the centre of a circular pool. The barograms give tidings of atmospheric movements comparable to gigantic waves of sound, starting from a small area

and encompassing the globe, several times in succession, completing each circuit in about 36 hours. The mean speed of propagation was about 700 miles an hour, less by 23 miles than the velocity of sound at zero Fahrenheit; the velocity, in fact, seems to have corresponded to that of sound in air at 20 or 30 degrees below zero.

Among other interesting observations noted in connection with this eruption are those relating to the propagation of sound. Authentic instances are recorded of sounds caused by the explosions being heard at distances of 1210, 1902, 2014, 2267, and 2968 miles, being quite the longest distances that sound has been known to travel. The English Report includes a number of interesting and instructive hypotheses. The concensus of opinion as to the red sunsets which formed so conspicuous a feature of the autumn evenings of 1883 is that they may be traced to Krakatoa. The general conclusions are admirably traced by Sir Robert Ball:

First of all it would be natural to ask whether the existence of volcanic dust in the air could have produced the optical effects that have been observed. This must be answered in the affirmative. Then it would be proper to inquire whether other volcanic outbreaks in other parts of the world, and on other occasions, had been known to have been followed by similar results. Here, again, we have page after page of carefully stated and striking facts which answer this question also in the affirmative. Next it would be right to see whether the sequence in which the phenomena were produced at different places in the autumn of 1883, tallied with the supposition that they all diverged from Krakatoa. The instances that could be produced in support of the affirmative number many hundreds, though it must be admitted that there are some few cases about which there are difficulties. Surely we have here what is practically a demonstration. It is certain that these optical phenomena existed. No cause can be assigned for them except the presence, at that particular time, of vast volumes of dust in the air. What brought that dust into the air except the explosion of Krakatoa? Most people find themselves unable to share the scruples of those who think there can be a doubt on the matter. Would another eruption of Krakatoa, followed by a repitition of all the optical phenomena, convince them that in this case, at all events, *post hoc* was *propter hoc*. Perhaps not, if they have already failed in being convinced by the fact that, when Krakatoa exploded two centuries ago, blood red skies appear to have been seen shortly afterwards as far away as Denmark.

ZOOLOGY.

UNSEASONABLE VISITORS.—Monmouth County, New Jersey, has had an open Winter, and with it some interesting phenomena. Among the fishing industries, crabbing is one, of which there are two seasons—the special and the general, the former being when the crabs are shedding their shells, and are known as shedders or soft-shells. In this condition they are considered a great luxury, and bring the highest prices. But the soft-shells only have a short season. The hard shells continue the year through, except in the winter, when they betake themselves to the mud. A shrewd fisherman found out that the crabs this Winter in Raritan Bay had not taken to the mud; so he continued to catch them, and owing to their good condition, and the unusual fact of getting them in the Winter, he got good prices. It was in vain that the man tried to keep his secret. It leaked out, and there was a rush which soon closed the business.

The common eel, also, in the Winter, hides in the mud; but the fishermen have continued to catch them in these parts this Winter.

In February, some men while clearing pine land with the grubbing hoe, at a depth of five or six inches, unearthed a nest of snapping turtles—*Chelydra serpentina*. There were four young ones, just out of their shells, the latter lying in the nest. They were soft, though frozen stiff. One told the other to handle them carefully, or the legs would break off. Taken to the house they soon thawed, and became very lively, but being kept through the night in a room without fire, they succumbed to the cold, and died. As these young reptiles usually do not appear until Summer, I was a little puzzled at this premature hatching. The fact too, that they could not endure the cold, after being once warmed, should have some significance.

About the middle of March we had our only real snowstorm, the fall being some six inches. It only lasted three or four days, but ere it had quite gone four snakes came out of the ground at Keyport. They varied in length from sixteen inches to two feet, and formed one company. My informant told me that he "went for them," but that the two largest got away into the bushes. From his description it is probable that they were garter snakes, but however innocent, or even useful, a

snake in the popular creed is "a varmint with no right to live."

On the 22d of March a fine male specimen of the giant bug, *Belostoma grandis*, was also caught in Keyport. The *quid nuncs* of the town were greatly exercised over the "huge cockroach!" One man, however, who "knew it all," said he had "lots of them roaches, only not nigh so big, in their kitchen." In my experience, this is a very untimely occurence of this fine insect, and the specimen was in excellent condition. The bug is bred in the water, issuing thence in the imago state generally in the Summer, and flying in the night. I have received a number of specimens from Asbury Park, and Trenton, which had been killed by dashing against the electric lamps. —*Samuel Lockwood.*

THE POISONOUS ARACHNIDA OF RUSSIA.—At a recent meeting of the Dorpat Naturalists' Society, Professor Kobert spoke of the reputedly poisonous spiders of Russia. According to the observations of Dr. Walter, of Jena, *Galeodes araneoides* is not poisonous, and does not even possess poison-glands. *Trophosa singoriensis*, the Russian Tarantula, is not poisonous to warm blooded animals, although it is to lower animals. In the case of *Latrodectes* 13-*guttatus* not only the poison-glands but all parts of the body contain an unformed protoplasmic poisonous ferment, which has much the same physiological effect when injected into the circulation as cyanic acid and strychnine.

NEW ORGANS IN THE COCKROACH.—Mr. Edward A. Minchin describes (*Quar. Jour. Micros. Sci.*, December, 1888) an ectodermal organ in the cockroach, which may possibly be a stink-gland. It consists of a pair of involutions of the cuticle on the dorsal surface of the abdomen, between the fifth and sixth segments, and opening by means of two slits near the median line, which are usually covered by the posterior margin of the fifth segment. Internally each pouch is lined by a chiterious cuticle, bearing numerous branched hairs, and beneath them glandular epithelial cells.

ZOOLOGICAL NEWS—MOLLUSCA.—J. I. Peck (*J. H. U. Circ.*, No. 70) describes the anatomy of the Pteropod *Cymbulopsis calceola*, which he studied by means of serial sections.

In the same place, Mr. S. Watase records a remarkable phenomenon in the segmentation of the egg of *Loligo pealii*. He

was successful in artificial impregnation and in tracing the histories of the various segmentation planes. The first plane is longitudinal, and for many stages an alternation of rest and activity on the opposite sides of this plane is noticeable. Thus at one time almost every nucleus on the left side shows distinct mitosis figures, while not a single nucleus of the right side exhibits such a feature. This was witnessed again and again, until the blastoderm contained 116 cells.

CRUSTACEA.—Professors W. K. Brooks and F. H. Herrick describe (*J. H. U. Circ.*, No. 70) some features in the development of the Peneid form *Sergestes hispidus*. It escapes from the egg as a protozoea, passes soon to the true zoea stage, and then to a mastigopus condition.

GENERAL.—Dr. H. V. Wilson gives an account (*J. H. U. Circ.*, No. 70) of the times of breeding of several marine forms at the Bahamas, which will prove of value to students visiting the West Indies.

WORMS.—Dr. Hurst records (*Notes from Leyden Museum*, January, 1889) the presence of *Arenicola cristata* (originally described by Stimpson from South Carolina) at Naples.

EMBRYOLOGY.

THE ORIGIN AND MEANING OF SEX.[1]—My hypothesis respecting the origin and meaning of sex may be stated provisionally as follows, pending a fuller sketch to be published in the immediate future.

1. Over-nutrition is regarded as the prime cause of the un-

[1] Seventeen paragraphs, or those numbered 1, 2, 8, 9, 12 to 18, 21, 22, and 25 to 28, of this article comprise all except 154 words, *verbatim et literatim*, of the first draft of a synopsis of the hypothesis here somewhat more fully presented. The Secretary of the Academy of Natural Sciences, of Philadelphia, advised the withdrawal of that first draft, which was offered for their *Proceedings*, on the ground that it was unwarrantably anticipated by the publication of the same matter in a supplementary notice, which was privately published by the author, with the same title, dated July 5, 1889, and which also forms part of the present article. This note is neccessary in order to correct any possible erroneous impression which may have arisen in the minds of those to whom copies of extras were sent of the first article, as to the latter's source, as it was printed, in advance of the issue of the signatures of the Academy's *Proceedings*, and bore the imprint of the latter.

equal growth of cells, or of individuals, if the latter are unicellular.

2. The differentiation of sexuality as a result of such unequal nutrition, through which a difference in potential of segmentational power was developed in consequence of physiological differentiation, accompanied by a great difference in size.

3. Over-nutrition in animals and plants has led to all the forms of sexual, asexual, and parthenogenetic reproduction.

4. The over-nutrition of ova, ovules, etc., through which they have grown beyond the average size of the other cells of the body of the parent, is proof that they have in some way lost the power to undergo spontaneous segmentation, except in the case of parthenogenesis, which will be dealt with more fully hereafter.

5. Over-nutrition of the male mother-cells, accompanied by an exaltation of segmentational power, has caused their products to become the smallest cells produced by the body, with a concomitant augmentation of latent segmentational power.

6. Ovum and spermatozoon are not homologous, but only sperm-mother-cells or groups of them and ova are homologous; the same law applies to the germ-cells of plants.

7. The production of the definitive sexual elements of the multicellular forms has proceeded *pari passu* with an extreme physiological differentiation of karyokinetic function in the two kinds, which stand in a reciprocal relation to each other, and which has been the cause of their reciprocal attraction for each other, leading to the act of fertilization.

8. The ability of such over-nourished cells to go on segmenting only as result of the union of such pairs of unequal dimensions, which stand to each other in a reciprocal relation of potentiality as respects segmentational power. The female cell has lost the power to spontaneously segment, whereas the male cell has acquired an exaltation of latent segmentational power.

9. The integration of such large masses of living matter as single units made it possible for the results of such segmentations to cohere, instead of falling apart. If, in fact, such prepatory accumulation of material had not occurred, rapid, simultaneous and successive segmentations would have been impossible, since *pari passu* with the differentiation of their segmentational function such germ-cells finally lose *in toto* the power to nourish themselves except when in a relation of continuity with the parent organism.

10. The aggregation of large masses of segmentable plasma has also enabled the products of such simultaneous and successive segmentations to cohere and remain a multicellular aggregate, and to thus lay the foundations and become the direct cause of all metazoan and metaphytic organization.

11. The over-nutrition of the female element and the augmentation of its mass has rendered possible complex series of simultaneous and successive segmentations, in planes of from one to three dimensions, and the development of embryos without need of other nutriment during the preliminary or larval stages of ontogeny, thus leading also to the evolution of all larval forms.

12. So long as living organisms remained unicellular they were enabled to vary and become adapted only within the narrow limits determined by their unicellular condition, yet we know how marked is variability, even in this low grade of development; proportionally far greater than in multicellular types.

13. The achievement of the multicellular condition, as I have supposed, produced new and more complex morphological relations leading to the manifold differentiation of physiological functions in relation to diversification of surroundings, thus introducing a new and most powerful cause or capacity for variations and adaptations under such diverse conditions.

14. It is thus seen that the evolution of sexuality is the indirect cause of variability, and that otherwise there could have been no such thing as a struggle for existence leading to natural selection amongst multicellular organisms—at least seeing that they must have been produced, according to this hypothesis, as a result of the development of sexuality.

15. Over-nourishment in the vegetable, then lead to the over-nourishment of the animal world and the over-production of germs or young in both, so that the rate of increase became augmented in a geometrical ratio, as supposed upon the Darwinian hypothesis, which, on the basis of the theory of the struggle for existence and the process of natural selection so evoked, accounts for the preservation of valuable or advantageous variations through survival and inheritance.

16. Over-nourishment, then, is, according to the present hypothesis, regarded as the primary cause of morphological differentiation under the stress of diverse conditions, as well as of the geometrical ratio of increase of such forms, and, consequently, of the struggle for existence.

17. The doctrine of over-nutrition consequently becomes

antecedent to that of Darwinism, since it accounts for the primary diversification of species on the basis of inequalities of cell-nutrition in all forms, thus seizing upon the diversification of the physiological powers of the primal forms of life as the first factors in biological evolution, and which gave the latter its first impulse and upon which all further impulses have been superimposed.

18. Sexuality is thus rendered the motive force of all biological development, but in a totally different sense from that hitherto held by any one else.

19. While sexuality thus viewed becomes the motive force of all biological evolution it also gives rise to the means of variability and a greatly augmented fertility of individuals, thus also leading to the struggle for existence and natural selection.

20. Sexuality is therefore found to transcend in importance the principle of natural selection itself, since over-nutrition only could have led to the over-production of germs and the consequent increase of individuals in a geometrical ratio, as assumed by the Darwinian hypothesis, and, since the vegetable world stands in an annectant relation between the not-living and animal world, it can be understood how the latter came to be over-nourished.

21. This hypothesis further assumes that, with the gradual circumscription and localization within more and more restricted limits, of the production of germ-cells, and *pari passu* with morphological differentiation, that the reproductive and recapitulative powers of the other cells of multicellular organisms became gradually less and less marked, owing to the gradually more intensified expression of the principle of the physiological division of labor in the evolution of organs with more and more definite functions.

22. It regards the hypothesis of the immortality and immutability of the *Keimplasma* as inadequate, and as absolutely disproved by the facts of morphological development alone.

23. The production of germ-cells has been localized more and more definitely as a result of the increasing morphological specialization of multicellular forms, so that the the hypothesis which assumes that the germ-plasma is precociously set aside in order to render it unmiscible with the somatic plasma, and therefore immortal, is based upon a fundamental error of interpretation of the facts of morphology.

24. The only cells in the multicellular forms which are ab-

solutely otherwise functionless are the germ-cells. They alone, therefore, can become the vehicles for the transmission of all the traits of the parent in higher forms, since they alone are otherwise functionally unoccupied, and are the only cells of the body which, by any stretch of the imagination, can be supposed, *a priori*, to possess the recapitulative power manifested in ontogeny.

25. It further assumes that the theory of the geometrical ratio of increase is qualified by the advent of multicellular forms as a direct result of the development of sexuality, and that, reckoning on the basis of cell generations, the ratio of increase in the animal and plant world is absolutely and relatively less than if living forms had remained unicellular.

26. It leads also to the assumption that biological evolution has been along definite lines, and not fortuitous or hap-hazard, as has been tacitly or avowedly assumed by some incautious but extreme partisans of the doctrine of natural selection.

27. This hypothesis is based on the assumption that the undifferentiated nucleated cell is the point of departure for all morphological and physiological differentiation, and that the first depends upon the character of the karyokinetic changes which go on within it, while the second depends upon the nature of its metabolism and the mechanical arrangement and constitution of the plasma through which such metabolism is manifested.

28. Upon this ground may be based a further development of hypothesis which gives a satisfactory explanation of parthenogenesis, pædogenesis, gemmation, temnogeny, metagenesis, and the recapitulative processes of ordinary sexual genesis.

29. In the production of female germs (ova, oospheres,) there occurs a prolonged process of intergration of plasma to increase the volume of the cell-body. In the production of male elements, (spermatozoa, antherozoids,) on the contrary, an actual process of elimination of plasma occurs, so as to reduce the cell-body to a minimum size and leave little remaining except the nucleus and its chromatin. The modes of production of the male and female elements therefore, stand in the most extreme contrast in respect to each other.

This hypothesis, founded upon data which have been hitherto apparently ignored, applies to both the animal and vegetable kingdoms, sex having probably arisen simultaneously

and independently in both, as soon as certain cells of coherent groups become over-nourished and incapable of further segmentation unless brought into contact and fused with the minute male elements, or one which, as we have seen, is the product of an exalted segmentational power which is transferred to the female element in the act of fertilization. Both kinds of sexual products were probably at first, and still continue to be, dehisced from the parent organisms as useless products of over-nutrition, after further recapitulative growth in the form of new axes or of individuals, growing in organic union, as in colonial organisms, became impossible, due to crowding, the culmination of seasonal growth or the morphological specialization leading to definite or constant formal individuality.

All the facts which I have been able to gather lead to the conclusion that there is a relation between the difference in size of the male and female elements as to the number and rapidity of the subsequent segmentations of the resulting oösperm or oösphere. If the elements are alike there will be comparatively few segmentations; if greatly unlike, many successive segmentations seem possible.

The foregoing hypothesis affords clews to the reasons for variations in the fertility of species, the origin of viviparity and placentation, the infertility of irrelated forms, the origin of food yolk in ova and of pelagic eggs, the evolution of primary and secondary sexual characters, the interrelations of plants and animals, and a consistent and simple theory of inheritance, which is in harmony with all the facts of reproduction in plants and animals.

This hypothesis also discloses some of the apparent reasons why there is so frequently a great difference in the size of the sexes, as in fishes, where the male is smallest, and especially in those arthropodous forms, in which the males are microscopic and attached to or parasitic on the females, as in some Copepoda and Cirripedia. The extraordinary feeding and nursing habits of social Hymenoptera, efficient in determining the sex or neutrality of offspring, also acquire a new significance.

The first steps by which the over-growth of the sexual elements through over-nourishment is seen in the most primitive of all known non-parasitic, free-swimming, multicellular forms, namely, *Volvox*. Its life history proves that the multicellular condition can be, and probably was, attained directly by the over-growth and subsequent segmentation of a single cell in

three planes, simultaneously and successively, with but little coherence, forming a delicate blastula, the cells of which are separated from each other by interspaces, and joined together by very slender protoplasmic bonds. Certain cells of this blastula-like organism grow directly into germs with exaggerated dimensions. The wall of the *Volvox* blastula is probably ectodermic and entodermic in its homologies, gastrulation is still to occur, but it is interesting to observe that already the germs are produced in a little more than one hemisphere only, which probably corresponds to the ectodermic portion of a Cœlenterate, while the empty, anterior, directive, and sensory pole is homologous with the entoderm of the latter. The tendency of the germ-cells to originate from the ectoderm in some Cœlenerates, therefore, may have an ancestral significance.

The over-growth of Protozoan or Protistan forms probably gave rise, through a series of segmentations, directly to such types as *Volvox*, and simulating the planula or blastula more or less closely. Gastrulation, under its various guises, as well as proliferation and delamination, also followed, with their consequences, which led to the direct development of the various forms of ciliated larvæ, at once ready to feed, undergo metamorphoses, and share in the struggle for existence.

This first larval development was probably rapid, and due to the same causes as are still seen to be operative in the development of ova, namely, rapid segmentation. The accumulation in the egg of a mass of plasma in excess of the average of its fellow cells or individuals, laid the foundation for the first and most primitive type of segmentation, namely, the holoblastic, before any yolk was added to the ovum, as is seen in the development of *Volvox*. This coherent aggregate was now an individual, ready to begin the struggle for existence, and with infinite capacity for variation, and with an augmented power of reproduction.

The ovum, according to this hypothesis, becomes the conservative factor in biological evolution in a new sense, while the male element imparts the power to undergo rapid segmentation, and to quickly achieve the larval state, when the interaction of the organism and the environment can be brought into play. The physiological activities of such plasmic aggregates as an oösperm are at first almost wholly karyokinetic, and but slightly metabolic; this renders possible the later and immediately subsequent anabolism through which further growth and

power is acquired. In the vegetable world there has, from the first, been a tendency to form plates, filaments, and later columns of cell aggregates, instead of the blastula form of animal types. Sexuality, or the development of male and female elements, therefore, has a meaning, fraught with consequences and promises which have culminated in the most wonderful morphological and adaptive specialization, and probably in definite ways, which might have been predicted had all the conditions been known.

N. B.—Finally, it is necessary to point out here that these views have little in common with those urged by Geddes. While a preponderance of anabolic activity may produce an ovum, as he supposes, how it is possible to conceive that processes of physiological disintegration or katabolism, such as are witnessed in the breaking down of protoplasm into simpler compounds, could result in the production of male-cells, I utterly fail to comprehend. That growth is accompanied by katabolism there is no doubt, but to assume that the tremendous energy with which karyokinesis manifests itself in spermatogenesis is merely an exhibition of preponderent katabolism, which must result in the enfeeblement of the cells so produced, stands in such obvious contradiction to all that we know of the male-cells, that such an erroneous view must be unhesitatingly pronounced inadequate and unfounded. Anabolism and katabolism, or the molecular processes by which protoplasm is built up and torn down, cannot be tortured into an equivalency with the widely diverse modes of manifestation of karyokinetic activity in the morphologically homologous ovum and sperm mother-cells.

The fundamental error lies in confounding ordinary physiological processes with special modes of the manifestation of karyokinesis, and since there is no other known instance of katabolism resulting in the breaking up of cells by rapid cleavage into small cells, such as those produced from spermoblasts, it may well be doubted if the equivalency sought to be established is anything more than fanciful. —*John A. Ryder.*

PHYSIOLOGY.[1]

GASKELL'S WORK.—The most important recent work on the physiology of peripheral nerves, is that of Dr. W. H. Gaskell, of Cambridge, which has occupied him during the past ten years.[2] Begun as a contribution to cardiac physiology, it has extended itself much beyond this, and bids fair to alter fundamentally our conceptions of the morphological and

[1] This department is edited by Dr. Frederic S. Lee, Bryn Mawr College, Bryn Mawr, Pa.

[2] Gaskell's chief articles are published as follows—

Phil. Trans. 1882. p. 993.
Journal of Physiology. Vol. IV. p. 43.
" " Vol. V. p. 362.
" " Vol. VII. p. 1.
Medico-Chirurgical Transactions. Vol. LXXI. (Contains a summary of results up to the receipt of the Marshall Hall Prize.)
Journal of Physiology. Vol. X. p. 153.

physiological natures of peripheral nerves. For this work the author received last year the Marshall Hall prize. An abstract of the results follows.

Gaskell began his work by the study of the innervation of the frog's heart. He found that the vagus not only inhibits but also accelerates the rate of the contractions. This led to the discovery that the vagus in the frog is in reality the vago-sympathetic, *i. e.* the nerve trunk consists in part of vagus fibres, in part of sympathetic fibres, the two uniting early in their course; the vagus fibres proper are inhibitory, the sympathetic fibres cause acceleration. Taking into account not only the primary effects of the stimulation of these fibres, but also the after effects, Gaskell came to the conclusion that "the process of inhibition is bound up with changes in the muscle of a beneficial nature to the further action of that muscle, while the action of the augmentor nerve resembles rather the action of a motor nerve, and causes an exhaustion of the muscular activity." He concluded, therefore, that "inhibition of contraction is the symptom of the action of an *anabolic* nerve *i. e.* a nerve which brings about constructive metabolism, just as much as contraction or augmentation of contraction is the symptom of the action of a *katabolic* nerve *i. e.* a nerve which causes a destructive metabolism." He further studied the nerve supply of the rest of the vascular system, and came to the conclusion that all tissues are supplied with two sets of nerve fibres, one anabolic in nature, the other katabolic.

In the study of the nerves of the tortoise's heart, he found that the sympathetic, or katabolic, fibres were all non-medullated, while the vagus, or anabolic, fibres were medullated. So here was a morphological difference bound up with a physiological difference, and the question arose, does this distinction hold good throughout the entire course

The efferent nerves of the body can be divided into groups according to their function. If this division be not purely artificial, the members of the different groups should agree with one another morphologically as well as physiologically. Gaskell made the following classification of efferent nerves, and studied the different groups with great care.

EFFERENT NERVES:

1. Nerves of the vascular muscles.
   (a) Vaso-motor, *i. e.* vaso-constrictors, accelerators and augmentors of the heart.

(b) Vaso-inhibitory, *i. e.* vaso-dilators and inhibitors of the heart.

2. Nerves of the visceral muscles.
   (a) Viscero-motor.
   (b) Viscero-inhibitory.
3. Glandular nerves.

He found that the "vaso-motor nerves for all parts of the body can be traced as bundles of the finest medullated fibres in the anterior roots of all the spinal nerves between the 10th and 25th, inclusive, along the corresponding *ramus visceralis* (white *ramus communicans*) to the ganglia of the lateral chain (main sympathetic chain) where they become non-medullated and are thence distributed to their destination either directly or after communication with other ganglia." The viscero-motor nerves are also fine medullated fibres which become non-medullated in the chain of sympathetic ganglia. As to the vaso-inhibitory fibres, these too start from the spinal cord as fine medullated fibres, becoming non-medullated in the collateral or terminal ganglia; the difference between the vaso-motor and vaso-inhibitory fibres lies therefore in the place where they lose their medulla, the former becoming non-medullated in the proximal ganglia, the latter in the distal ganglia. The viscero-inhibitory fibres agree with the vaso inhibitory just as the viscero-motor agree with the vaso-motor. The conclusion arrived at from this work is that "the vascular and visceral muscles are throughout supplied by two kinds of nerve fibres of opposite function, the one motor and the other inhibitory; and that further these two kinds of nerve fibres reach the muscle by separate, distinct anatomical paths, the difference of path consisting in a difference of origin from the central nervous system combined with the fact that the inhibitory nerves lose their medulla in more distant ganglia than the corresponding motor nerves." Moreover, the investigation of the course of the efferent nerves led Gaskell to regard the sympathetic and homologous ganglia as the motor or efferent ganglia of these visceral fibres; so that instead of the old conception of two nervous systems which interchange fibres with each other, he would substitute the following definition of the nerve belonging to a spinal segment— "A spinal nerve is composed of anterior and posterior roots both ganglionated, the ganglion of the afferent root always being stationary, while that of the efferent root is vagrant and has traveled away to various distances from the central nervous system,"

these vagrant ganglia being the ganglia of the sympathetic system.

The results of Gaskell's latest work concern the relation between the spinal and cranial nerves. In order to make a comparison between these two, it is necessary to have a clear idea of a complete spinal nerve. According to Gaskell such a nerve consists of— 1. A posterior root composed of afferent fibres, both somatic and splanchnic, the ganglion of which root is stationary in position, and is always situated near the entrance of the fibres into the central nervous system. 2. An anterior root composed of (1) efferent, non-ganglionated, splanchnic and somatic fibres, and (2) efferent, ganglionated, splanchnic fibres, characterized by the fineness of their calibre, the ganglion of which is vagrant and has traveled to a variable distance from the central nervous system. The cranial nerves are then considered seriatim.

The optic and olfactory nerves do not conform to the type of a segmental nerve and are not discussed.

The IIId nerve is efferent in function. It consists of large and small fibres; as it approaches the oculomotor ganglion the large fibres pass off to supply the eye muscles and the small fibres form a separate group and pass into this ganglion, which is therefore considered a typical motor ganglion. The IVth nerve is also efferent in function, and consists of a large fibred and a small fibred portion, but no ganglion cells have been found along its course. As to the afferent fibres of these nerves—both the IIId and IVth possess within themselves degenerated structures which appear to Gaskell to have been originally the nerve cells and nerve fibres corresponding to the cells and fibres of the stationary ganglion on the posterior root of a spinal nerve. These two nerves, then, form the primary segmental nerves of the first and second segments, the function of the degenerated sensory elements being performed by the *ramus ophthalmicus profundus* of the Vth.

The VIth is purely motor; it contains somatic fibres, while the so-called motor part of the Vth contains splanchnic efferent fibres, but no somatic ones; therefore, taking these two nerves together, we have a complete segmental nerve, as far as efferent fibres are concerned. Here, again, we find that the roots of the motor part of the Vth contain within themselves the remains of nerve fibres and ganglia which would correspond to the afferent fibres and posterior ganglion. The *ramus maxillaris superior* of the Vth, which with the *ramus ophthal-*

micus profundus originates in more posterior segments, has replaced the lost sensory elements of the original nerve of the third or mandibular segment.

The VIIth nerve is a splanchnic efferent nerve consisting of both large and small fibres, the small fibres passing into the geniculate ganglion, which would therefore be the ganglion of the anterior root. As to the somatic efferent fibres, Gaskell has not been able as yet to find these. In this nerve, too, the degenerate remains of the sensory fibres and ganglion are found.

The VIIIth nerve is dismissed from consideration, since it is a nerve of special sense, and this might possibly justify its claim to an independent position. Summing up, then, we find that "in the group of motor cranial nerves, formed by the IIId, IVth, VIth and motor part of the Vth, and VIIth nerves, we have at least four fully formed segmental nerves which for some reason or other have lost a certain portion of their original components."

"In the group of nerves which arise from the medulla oblongata we find all the components which make up a fully formed spinal nerve, or rather group of nerves; here, however, there is no sign of any degeneration of any special group of fibres, but rather a dislocation and scattering of the different components, so that the cranial nerves of this group form parts of a number of segmental nerves instead of each one forming a single nerve." Both the IXth and Xth are purely splanchnic nerves. Each possesses two ganglia: the *ganglion jugulare* and *ganglion petrosum* on the one hand, and the *ganglion jugulare* and *ganglion trunci vagi* on the other. Gaskell considers that the two jugular ganglia represent the stationary afferent ganglia of the IXth and Xth nerves, while the *ganglion petrosum glossopharyngei* and the *ganglion trunci vagi* represent the vagrant efferent ganglia. The spinal accessory consists of large and small fibres. The large ones arise in all the roots of the nerve, the small fibres are confined to the medullary and upper cervical roots, and pass into the *ganglion trunci vagi.* All the fibres are splanchic efferent fibres. The hypoglossus is a purely somatic motor nerve. It represents the separated somatic efferent fibres of this region.

The origin of the fibres of the cranial nerves as well as the structure and function of their peripheral nerve fibres, goes to prove the spinal nature of the cranial nerves, for the groups of cells, which give origin to the cranial nerves, are the direct

continuation of the corresponding cell-groups found in the spinal region.

Having homologized the spinal and cranial nerves, Gaskell formulates a theory of the origin of the central nervous system of vertebrates, to explain the degeneration in the anterior groups of cranial nerves. The central nervous system of the vertebrate, considered anatomically and morphologically, suggests two modes of origin which are apparently antagonistic to each other. The segmental arrangement of the nerves and the cells, from which they arise, points to the conclusion that the nervous tissue of the animal, from which the vertebrate arose, was arranged in a distinctly segmental manner. On the other hand the evidence of embryology points to the fact that the formation is tubular. Any theory must then take both these into account. Schwalbe concludes that the evidence points to the origin of the spinal cord from a bilateral chain of ganglia connected together by means of transverse and longitudinal commissures. Gaskell adopts Schwalbe's view, with the addition to this system of another system of higher function, *i. e.*, the cerebrum, cerebellum, etc., connected with the spinal system through the pyramidal tracts, the direct cerebellar tracts and others. This system is not represented in the spinal cord, and does not give rise to any outgoing nerves except nerves of special sense. Beside the nervous structures of the cord, we have the supporting structures; both of these arise from the medullary tube. As to the connection between these two structures, Gaskell holds that both phylogenetically and ontogenetically the evidence points to the fact that "the central nervous system of the higher vertebrate has been formed by the spreading and increase of nervous material over the walls of an originally non-nervous tube, the cellular elements of which tube, whatever may have been its original function, have been utilized as supporting structures or have undergone gelatinous degeneration. Tailwards this tube emerges free from the encasing mass of nervous matter as the neurenteric canal and its walls are continuous with those of the alimentary canal. Headwards this tube passes into the third ventricle and has apparently no anterior opening." The spinal system of vertebrates corresponds to the infra-œsophageal ganglia and ventral chain of invertebrates, while the crura cerebri, peduncles of the cerebellum and other tracts extrinsic to the level of the ventral ganglion chain form the œsophageal collar, the system of higher function corresponding to the supra-

œsophageal ganglia. It follows necessarily that the tube around which the nervous matter has been formed, *i. e.*, the central canal and ventricles, represents part or the whole of the alimentary canal of the vertebrate ancestor. The author believes that he has found in the infundibular region the remains of the terminal œsophageal tube. In the light of this view we have sufficient reason for the degeneration of certain components of the foremost group of nerves, for with the loss of function of the invertebrate alimentary canal, and mouth parts in connection with it, the sensory parts of the nerves supplying that region degenerated.—*Leah Goff.*

ARCHÆOLOGY AND ANTHROPOLOGY.[1]

ANTHROPOMETRY AS APPLIED TO THE DETERMINATION OF THE ATTRIBUTES OR POWERS OF THE MIND OF MAN.—This is a problem. My only purpose is to consider its feasibility. Its benefits will be apparent. Can it be done?

It will not do, in this age of science, to determine on the entrance to the consideration of a given subject that its discovery or elucidation is impossible because of its extent, distance, mystery, or difficulty. These may be a bar to its discovery, but not to its consideration or attempted discovery.

The scientific discoveries made within the last few years are sufficient answer to this. What question presents greater apparent difficulties—impossibilities that the knowledge that the composition of the flame of the sun or the fixed stars—yet the solar and stellar spectrum has resolved these into their original elements, and we know them as well as we do that of the candle or the coal, which burn before our eyes.

Professor Langley has just informed us that the greater part of the sun's rays are not luminous, and that those which are, are really blue, and not white.

Who could have foreseen that when Galvani, of Bologna, in dissecting a frog (what nonsense, for a great philosopher to fool away his time dissecting frogs!), should have touched with a wire a given nerve, and that the twitch it made in response to his touch should have since then run through a million

[1] This department is edited by Thomas Wilson, Esq., Smithsonian Institution, Washington, D. C.

miles of wire, over the land like the network of the fowler, and through the sea like the seine of the fisherman, until with its sudden cession, the trade, commerce, and government of the world would come to a standstill?

Professor Bell, one of our countrymen, has taken one of these wires—it may be a thousand miles long—and put on it at one end a patent mouth and at the other a patent ear, which can speak and hear with as much distinctness as if they were both attached to the same head.

The latest invention is a machine, about the size of a small sewing machine, into which one may speak in his natural voice, then boxing up his speech, may, after a thousand years of time, or at a thousand miles distance, by the simple turning of a crank, unwind the same speech in the same tone and voice as it was spoken.

Surely, there is much new under the sun.

After this preamble upon the possibilities of science, let us see if we may not measure and record in figures the attributes of man's mind.

Man holds communication with the outside world through his five senses. The action of either of those produce a sensation. Sensation produces perception, and perception intelligence. If we can measure the sensation we are on the road to measuring the perception, and so on, to the understanding and intelligence, and possibly the mind in its more subtle and abstruse operations.

What a conquest of science if we could be able to measure the sensations produced upon the mind, and passing through the upward scale, to calculate the mental force expended, say by Webster in his great constitutional arguments, or by determining the vividness and depth of perception, and so of understanding; to be able to calculate, by mathematical formulas, the reserve mental power necessary to make such arguments.

Decision requires an entire mental operation. It pre-supposes choice; choice, discrimination; discrimination, impression or sensibility; and this, sensation, which is obtained through one of the organs of sense. The operation of this organ, say of sight, can be easily measured, and one step accomplished. Is it not possible to continue it further?

The higher and more complex operations of the human mind may not now be measured. But why not the lower and simpler? When thus measured in different individuals may not their differences denote their differences in mental calibre?

One child knows a letter or figure, remembers it, understands it, on seeing it once; another requires twenty times; while the learned pig can only spell or count on being shown the same letter or figure, a hundred, maybe a thousand times.

Animals can be taught many mental operations. I recall the performing elephants, dogs, bears, monkeys, birds, even the fly and the flea, while Sir John Lubbock has ascertained the sensibility of the ant in the matter of sight, hearing, smell, and has shown that he can receive impressions through these senses which lead up to perception, understanding and decision. Sir John discovers that the ant has a goverment, and consequently a governor. He will emigrate to any other country, can organize an army, make raids, fight battles, take prisoners whom he enslaves. It is highly interesting to count the needed sensations, impressions, and perceptions required to perform all these mental operations.

The same system by which this can be measured or counted in our experiment with the animal can be applied to man.

What are school examinations or college commencements but tests by measurement or counting of the mental capabilities of the students? They may be only for comparison one with another; but that comparison is made by measurement more or less indefinite. At West Point and Annapolis the comparison is made with an absolute standard, in which 1000 is perfection. The system may be anomalous, for unblacked shoes and unkempt hair may so reduce it as to defeat his promotion.

Color blindness and astigmatism are measured by the oculist. They may be diseases or caused by defective mechanism, but these are only determined by measuring the sensations produced in the mind.

The measurement of a mental sensation is something accomplished, and I would pursue the same line of investigation to its end. Examine the candidate for the *truthfulness*, the *fidelity* of his sensation. First as to his sense of color. The question is, what sensation is produced upon his mind by the sight of a strand of worsted of a given color? Does green give the proper sensation, or purple, or red? This is a test of the *correctness* of the impression as to color. The operation is done leisurely. Rapidity is not now required. It is *accuracy* which is now being tested. As his examination progresses mark on the chart his successes or his failures. The fault in his sense of color may result from a species of disease. But

now we test his sensation as to size, form, etc., which is not affected by disease, but it is a question purely of truthfulness of sensation or impression. Show him a yard stick, and let him mark the middle of it—divide it into feet or inches. Let him do it slowly but correctly. Compare two lengths—draw parallel lines, some true and some untrue—try him with angles, right, and other than right. Invent methods to test the correctness of his impression on his mind as derived from the operation on the sense of sight.

As a second lesson or course give him the chalk and let him make on the board the lines which he has just tried. Let him make a straight line of certain length; an inch, a foot, a yard —a right angle, a square, a circle, parallel lines, etc., etc.

Having exhausted correctness, test him for rapidity—have him do the same things and in addition to correctness, require rapidity.

To correctness and rapidity in such elementary matters let us add the test of power of observation, that is, the capacity to *see* things, to see them correctly, rapidly, and to note their number, position, quality, etc. This is only to note the sensation obtained from a larger view than the sticks and lines first shown. It is still the mental impression derived from the operation of the sense of sight.

March the candidates or class into a room, stay five minutes, and out again—then describe every article seen; try one minute; try unfamiliar rooms; try a picture; conduct them past an open door at a slow pace, and then ask them to tell every article seen in the room.

All these tests can be registered for each candidate, and the result will be his mental capacity in each of these regards, correctly expressed in figures.

Then try him with the sense of hearing, of touch, possibly of smell. You will say this will sharpen his senses. I prefer to say it will sharpen his *wits*—that it educates him, it causes him to correctly note the impression of the object as presented to the senses and as correctly to report or carry it to his mind. All this is but that mental quality called attention. After attention, memory. Thus we may measure by Anthropometry the mental qualities of sensation, impression, attention, and memory.

These are the faculties by which the mind of man receives its communications from the world. By their means it obtains the raw material to be worked up in the laboratory of thought.

MEASUREMENT OF MAN'S REASON.

How many are twice two? Twice ten? Easy enough to tell. How many are twice 17.648? Seven times that? Twelve times that? The mental operations required are those we have just been measuring, and we who have perceived in them the highest grade will succeed here the best. First attention to impression and sensation, then correctness, and finally, rapidity. All these tests to be recorded. Thus we may progress through mathematics, logic, philosophy, and so on to the end, practicing continually our first and fundamental rules of Attention, and Correctness of Impression, or Sensation.

The thoughtful man can follow this system out in detail, can perceive how it can be accomplished. I can see how, by the introduction of some such system, not only the average mental capacity or power of a nation or a people might be measured, the result announced in figures, and a comparison made with other nations; also that its use might tend to increase that capacity and power.

Such are the higher uses of Anthropometry. The human mental capacity *to understand* things is nearly allied to its capacity to *see* things. If one can be done I should not despair of the other. Whatever can be done with either must be by experiment directed by observation, Experiments must be repeated and the observations recorded. This means counting and measuring; and this applied to man is the Science of Anthropometry.

These are some of the possibilities of Anthropometry, but they are as yet far beyond the scientists of the United States.

We must content ourselves for the present with obtaining full, complete, and reliable tables of measurements of the physical peculiarities of the various races which inhabit our country. This should be our immediate contribution to the world's science.

MICROSCOPY.[1]

THE RETINA OF THE BIRD. — Cajal[2] recommends the method of Golgi for the study of the retina. He proceeds as follows:

[1] Edited by C. O. Whitman, Clark University, Worcester.

[2] Anat. Anz., iv., No. 4, Feb., 1889, p. 112.

The fresh retina is left for two or three days in a mixture consisting of

Bichromate of potassium (3 %) - -	4 parts
Osmic acid (1 %), - - - - -	1 part.

It is next placed in nitrate of silver solution (¾%) 24-30 hours. The sections are cleared in oil of cloves and mounted in damar.

CELL DIVISION.—Rabl[1] recommends the following method of preparation for the study of the caryokinetic phases in Triton.

The larvæ are treated with chloride of platinum ($\frac{1}{10}$ - $\frac{1}{8}$ %) 24 hours, then thoroughly washed in water, and slowly hardened in alcohol. The floor of the mouth and the gills are then cut out, stained in Delafield's hæmatoxylin, or Czokor's alum cochineal, *and examined in methyl alcohol.* In media of higher refractive index the finer details are not seen. The preparations last only for a few days.

DEMONSTRATION OF THE TONOPLAST.–Professor Vries[2] has shown that the vacuoles of plant cells represent organs with distinct and very resistant walls. In harmony with its function the wall is called the tonoplast. Aleuron granules are tonoplasts with their contents in a dried condition. The demonstration of the tonoplasts is accomplished by a 10% solution of nitric acid reddened with eosin. The method may prove useful in the case of animal as well as plant cells.

THE PRESERVATION OF ACTINIÆ.[3]—The preservation of Actiniæ in a suitable condition for future study is a matter of some difficulty, and has greatly hindered a thorough study of the group. The great difficulty experienced in killing the animals sufficiently rapidly to prevent contraction is the main obstacle, and the method of first producing torpor by the use of chloroform or nicotine, as practiced by the Hertwigs ('79), is tedious and not always successful. I was in hopes that good results might be obtained by the use of cocaine, but my experiments with it gave negative results. The success of any method depends greatly on the character of the form under

[1] Anat. Anz., iv., 1, Jan. 10, 1889, p. 30.

[2] Hugo de Vries, *Intracellular Pangenesis*, 1889, p. 150.

[3] J. Playfair McMurrich, Actiniaria of the Bahamas, Journ. Morph., iii., 1, p. 2, 1889.

treatment. Methods which will give good results with the Zoanthidæ, for instance, will yield failure quite as often as success with more contractile forms. For a collector who cannot give the time required for the proper carrying on of the narcotizing methods, my experience has led me to advise the following method of procedure. After the general characteristics —the coloration, presence or absence of tubercles, the dimensions, and such easily observable features—have been carefully noted with as much detail as possible, the animal is placed in a jar just wide enough to allow its complete expansion, and with just enough water to cover it when fully expanded. When this condition is reached, a glass syringe is filled with Perenyi's fluid, and this is suddenly and rapidly injected into the interior of the animal, the nozzle of the syringe having been quickly inserted into its mouth. At the same time, if possible, a quantity of the same fluid is poured over the animal, so that it is bathed without and within with a tolerably strong mixture of Perenyi's fluid. It is left to the action of the fluid for about half an hour, and is then to be treated successively with 50, 70 and 90 per cent. alcohol, care being taken to inject a considerable quantity of the spirits into the interior at each change.

Although considerable contraction usually results from this process, and although the color is, as a rule, almost destroyed, yet I think the distortion is less than that resulting from most other methods, and there is the great advantage that the parts are preserved in a satisfactory manner for future histological study. Dissection is possible, owing to the absence of the excessive brittleness which results from the use of chromic acid, encrusting or attached calcareous particles are dissolved, and sectioning of entire small forms may be practiced without the danger of ruining the knife, and lastly, there is no unpleasant precipitation of crystals as occurs from the use of corrosive sublimate when the subsequent washing has not been sufficiently prolonged.

THE PREPARATION OF BONE AND TEETH WITH THEIR SOFT PARTS.[1]—Dr. L. A. Weil takes only fresh, or nearly fresh teeth, and in order to allow reagents and stains to penetrate into the pulp cavity, divides the tooth immediately after extraction with a fret-saw, below the neck, into two or three

[1] *Internat. Monatschr. f. Anat. u. Physiol.*, v., 1888, Heft 1, *Journal Roy. Mc. Soc.*, 1888, Dec., p. 1042.

pieces, "allowing water to trickle over it the while." The pieces are then laid in concentrated sublimate solution for some time to fix the soft parts. After this they are washed in running water for about one hour, then placed in 30 per cent. spirit, which in twelve hours is changed to 50 per cent., again, after a similar period, to 70 per cent. Then, in order to remove the black sublimate precipitate, the teeth are laid for twelve hours in 90 per cent. spirit, to which 1.520 per cent. tincture of iodine has been added. The iodine is afterward removed by immersion in absolute alcohol until the teeth become white.

For staining, alcohol, or an aqueous solution of borax carmine, gave the best results. From the absolute alcohol the teeth are removed to running water from fifteen to thirty minutes, and then placed in the stain. In the aqueous solution of borax carmine they remain one or two, in the alcoholic two or three days. They are then transferred to acidulated 70 per cent. alcohol (alcohol 100 ccm., acid. muriat., 1.0) in which they remain, the aqueous ones stained at least twelve, the alcohol-stained ones twenty-four to thirty-six hours. This done they are immersed for about fifteen minutes in 90 per cent. alcohol, and then for half an hour in absolute alcohol, after which they are transferred to some etherial oil for twelve or more hours.

The oil is then quickly washed off the objects with pure xylol, and then they are placed for at least twenty-four hours in pure chloroform. After this they are passed into a solution of balsam in chloroform. The balsam is prepared by drying in a water bath, heated gradually up to 90°, for eight hours or more, until when cold the mass will crack like glass on being punctured. Of this balsam so much is added to the chloroform as to make a thin solution in which, as before mentioned, the teeth lie for twenty-four hours. After this time as much balsam is added to the solution as will dissolve. When no more balsam will dissolve, the teeth and a sufficiency of the balsam are poured into a vessel and heated up to 90° in a water bath, until the mass when cold should be as hard as glass. When the balsam is sufficiently set the teeth are carefully picked out, placed in a vice, and their discs are cut from them with a fret saw, water being allowed to trickle over them the while, and then they are ground in the usual way. The preparations are mounted in chloroform balsam.

MINERALOGY AND PETROGRAPHY.[1]

PETROGRAPHICAL NEWS.—Dr. G. H. Williams[2] has identified upon the island of Fernando de Noronha, the following rock types: hornblende-trachyte, trachyte glass, hornblende-andesite, phonolite, nepheline rocks, augitite, limburgite and basaltic bombs and tuffs. In the phonolites, ægerine occurs both in porphyritic crystals and in the groundmass. In the crystals of the groundmass the inclination of the axis of greatest elasticity to the vertical axis is $7° 42'—16°$. Their pleochroism is B = green, A = green, C = yellow. Among the nepheline rocks are basanites, dolerites and basalts. In the dolerites are brownish-red augite crystals which are distinctly pleochroic in reddish-brown and greenish-yellow tints. They are zonarly developed with the exterior zones more highly colored than the interior ones.—A recent article by E. S. Dana[3] in the petrography of the Sandwich Islands is so full of interesting statements that a brief review of it is very unsatisfactory. The lavas of Mauna Loa and of Kelauea are of the same general character. They are basalts and olivine-basalts in numerous varieties. A fine-grained clinkstone-like basalt from Loa is remarkable for the beautiful feather-like groupings of augite microlites discovered in all specimens examined. Many of the augite microlites are intergrown with lath-shaped crystals of plagioclase, the two minerals radiating from a common center, and the latter often capping the tufts of the former. The olivine-basalt from the same crater contains many crystals of olivine in peculiar forms, some of which are slender acicular crystals elongated in the direction of their c axes. They often possess an unusually deep green color, when they show strong pleochroism. In the Mt. Loa lava streams are caverns from whose walls delicate stalactites of lava project. These are described by the author in great detail and are pictured with great minuteness. The stalactites are often solid throughout and possess a concentric structure. They are crystalline, except on the outside, where they are covered with a thin coating of glass, transversely marked with fine flowage lines. Frequently a large portion of the volume of a stalactite consists of cavities, whose walls are lined with large rhombic scales of clear plagioclase, needles of augite and octhedra

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2] *Am. Jour. Sci.* March, 1889, p. 178.

[3] Ib. June, 1889, p. 441.

of magnetite. The lavas of the island of Maui and of Ohua are also principally olivine-basalts, in which augite is often zonally grown around olivine crystals. In the western portion of Maui is a whitish-gray compact rock, composed almost exclusively of plagioclase, with a very little altered hornblende, brolite and magnetite. Since it contains 61.63% of SiO_2 it is probably to be referred to the andesites.—An interesting communication by Rutley on the possible origin of epidosites appears in the Quarterly Journal of the Geological Society.[1] Altered felsites with a perlitic structure occur near the Hereford Beacon, Malvern Hills. The rock is gray in color, and is traversed by a delicate network of quartz veins containing epidote grains and curved lines of epidote, which by their green color and strong double refraction mark out the direction of formerly existing perlitic cracks.[2] The epidote is thought to have originated from the feldspar of the felsites, either directly or indirectly through the interposition of kaolin by the action of solutions of carbonates of calcium and iron, which would naturally circulate most readily through the perlitic cracks. By a continuation of this process epidosites might arise through the entire change of the material of the felsite into epidote and quartz.—The ejectamenta thrown out by Vulcano have recently been studied by Johnston-Lavis.[3] The most abundant products of this volcano are bombs whose surfaces are broken by fissures, and pieces of foreign rocks. The material of the bombs is obsidian, containing as inclusions pieces of basic rocks, and minerals resulting from these by alteration. The ashes accompanying these bombs consist of fragments of basic and acid glassy rocks, which the author believes to have been broken from the sides of the volcanic vent. The existence of pyrites in the material of the bombs, as well as the presence in it of olivine and augite with perfectly sharp angles, leads to the conclusion that the temperature of the lava from which the bombs were formed was low.—The obermittweide conglomerate from a point in the Mittweide valley, twenty-five miles south of Chemnitz, has been subjected to investigation by Bonney,[4] who finds the matrix to have been derived largely from the detritus of a biotite granite, and to have undergone

[1] November, 1888. p. 740.

[2] Am. Nat., 1887, p. 1112, where it is stated that the author regarded the mineral filling the cracks as topaz.

[3] Nature, p. 111.

[4] Quart. Jour. Geol. Soc., 1888, No. 173, p. 25

such alteration that it may now be regarded as crystalline. It consists of quartz, two micas, and a little feldspar. The constituents exhibit a slight tendency to parallelism, but show little evidence of squeezing.—The same writer[1] announces the discovery of a variety of picrite, known as scyelite, on the island of Sark in the British Channel. It is composed of serpentinized olivine, altered augite and bleached mica, some of which exhibits a banded twinned structure, one set of bands extinguishing parallel to the cleavage of the mineral, and the second band 18° to this cleavage. The rock was not found in place.—Joly[2] has discovered the presence of iolite in a feldspathic substance associated with beryl in the granite of Glencullen Co., Dublin, Ireland.—Upon treating the quartz-porphyry from Teplitz with hydrofluoric and sulphuric acids, von Foullon[3] obtained in the residue little grains of corundum.

MISCELLANEOUS.—In a little pamphlet entitled "Ueber das Verhalten der Silicate beim Uebergange aus dem gluthflüssigen in den festen Aggregatzustand," Nies[4] discusses the occurrence of crystals of silicates in lava streams, describes the action of water, metals, and alloys in passing from the solid to the liquid state, calls attention to the contraction forms in eruptive rocks, and concludes that silicates probably expand upon their crystallization from a molten magma, and do not contract as has been generally stated, but that not enough facts are known to warrant a positive statement on either side. The apparent contraction is due to the fact that the specific gravities of crystallized and amorphous bodies have been taken while both were cold, and, therefore, that they can not be regarded as criteria upon which to base conclusions as to the relations of the substances in the two different conditions at a high temperature. Their different relations at a higher temperature are due to the more rapid expansion of crystalline substances than of amorphous ones.—An interesting contribution to the study of morphotropism has recently been made by Dufet,[5] who has carefully investigated the mixed crystals produced upon the evaporation of a solution of zinc and magnesium sulphates. As a result of his measurements of certain

[1] Geol. Magazine, March, 1889, p. 109.
[2] Geological Magazine, 1888, p. 517.
[3] Verh. I. k. k. geol. Reichsanst. 1888. No. 8, p
[4] Stuttgart. 1888. Schweizerbartsche Verlagshand.
[5] Bull. Soc. Franç. I Min. xii. p. 22.

interfacial angles he concludes that the values of these are the means of the values of those of the two simple sulphates, calculated in the proportions of their molecular combinations. The author proposes to study other mixed salts in the same way. McMahon[1] makes use of a thin quartz wedge for the determination of the strength of the double refraction of minerals in their rock sections. The quartz wedge is inserted between the crossed nicols of a microscope at an angle of 45° to their planes of polarization, and the point is noted at which there is no double refraction apparent when the object under investigation is placed on the microscope stage. This point of no double refraction is indicated by a dark line crossing the field. Its position varies with the strength of the double refraction of the mineral, so that by comparing its distance from the end of the quartz wedge with the distance observed in the case of minerals of known strength a ready means is afforded for a rapid determination of its double refraction.

Heririg[2] mentions the existence of a grotto in the Waschgang Mine at Döllach in Corinthia, whose walls are covered with well formed ice crystals, some measuring as much as 200 mm. in diameter.—Fulgurite glass from lightning tubes in a glaucophane epidote schist, in which occur yellow garnets, sphene, and occasionally diallage, is described by Rutley from the top of Monte Viso. The interesting fact in connection with this fulgurite is the existence in the tubes of a vesicular glass in which gas bubbles, and globulites and microlites are scattered.

In an article entitled the "Physics of Metamorphism," Harker[4] calls attention to the influence of pressure in effecting changes in the character of rock masses, and divides metamorphism into hydrothermal dynamo, and plutonic metamorphism, the meaning of each of which terms he explains in some detail In a red copper slag from the Canton Copper Works, Baltimore, Messrs. Jarman and McCaleb[5] have discovered cuprite in little octahedral crystals.

MINERALOGICAL NEWS.—Much additional[6] knowledge in regard to the sulphates occurring near Copiapo, Chili, has

[1] Geological Magazine 1888, p. 548.

[2] Zeits. f. Kryst. xiv. p. 237.

[3] Quart. Jour. Geol. Soc., Feb. 1889, p. 60, and Geol. Mag., 1889, p. 42.

[4] Quart. Jour. Geol. Soc., 1889, p. 15.

[5] Amer. Chem. Jour. Vol. II., p. 30.

[6] AMERICAN NATURALIST, 1888, pp. 930 and 1022.

been gathered by Luck,[1] who has made an extensive crystallographic and chemical study of them. *Coquimbite* is declared to be rhombohedrally hemihedral with $a : c = 1 : 1.5613$. Its hardness is 2—2.5 and specific gravity = 2.079—2.114. *Copiapite* has been determined to be monoclinic with $a : b : c = .4791 : 1 : .9759$ and $\beta = 71° 56'$. The mineral cleaves parallel to $\infty P \infty'$ and $\frac{4}{9} P\overline{\infty}$. Its hardness is 2.5 and specific gravity 2.103. Analysis yielded:

SO_3	Fe_2O_3	Ae_2O_3	CaO	H_2O
38.91	30.11	tr.	30.74,	

corresponding to $Fe_4 (HO)_2 (SO_4)_5 + 18$ Aq. *Stypticite* occurs in radially fibrous aggregates of a yellowish-green color. Its hardness is 2.5 and specific gravity 1.857. Its crystalization is probably monoclinic. Its composition was found to correspond to $Fe_2 (OH)_2 (SO_4)_2 + 9$ Aq. Upon alteration it gives rise to a grayish-yellow substance what is probably identical with *fibro ferrite*. Tabular crystals of *römerite* and found to be triclinic with $a : b : c = .9681 : 1 : 2.6329$ and $\alpha = 116° 2' : \beta = 94° 41' : \gamma = 80° 8'$. Its cleavage is basic, hardness 3 and specific gravity 2.102. An analysis of pure material leads Linck to regard the mineral as $Fe (Fe Al)_2 (SO_4)_4 + 15$ Aq. Chilian *halotrichite* yielded on analysis:

SO_3	Ae_2O_3	Fe_2O_3	FeO	CaO	MgO	H_2O
33.98	10.43	.95	5.55	.69	.78	46.94

Among these sulphates is one occuring in reddish-violet, tabular crystals, in habit resembling gypsum crystals. It is monoclinic with $a : b : c = .3942 : 1 : .4060$. $\beta = 77° 58'$. Most of the crystals are elongated in the direction of the clino diagonal. The plane of the optical axes is in $\infty P \infty'$ and the first bisected is inclined to c in the obtuse angle β. The the double refraction is negative, hardness 2.5, specific gravity 2.1155. Its composition is

SO_3	Fe_2O_3	Al_2O_3	CaO	MgO	H_2O
39.83	27.66	tr.	.40	tr.	31.35

corresponding to $Fe_2 (SO_4)_3 + 10$ Aq. The author calls the mineral *quenstedite*.—Some interesting pyrite crystals are described by Mr. W. B. Smith[2] from the mines in Gilpin and Summit counties, Colorado. The crystals from the Saratoga mine in the former county are remarkable for the large num-

[1] Zeits J. Kryst. xv. p. 1.

[2] Proc. Colorado Scient. Soc. 1887, pp. 155 and 17

ber of forms occuring upon them. Interpenetrating crystals with the twinning axis normal to ∞O, consist of modified cubes, which are brought into such a position by twinning that the striations on parallel cubic faces cross each other at right angles. Other crystals contain on their cubic faces striations that appear to be discontinuous. The crystals are probably contact tronis with ∞O ∞ the composition face. The crystals from Summit county occur in almost ideal perfection in a mass of kaolin in the vicinity of Monte Zuma. *Alabandite* from the Queen of the West mine in Summit county, *manganite* from Devil's Head, Douglas county, crystals of *dioptase* (∞P2 and —2R) from near Riverside, P.O., Arizona, and *garnets* from Chaffee county, Col., are also described by the same mineralogist. Repeated trillings of *vanadinite* from the Alice mine, Yuma county, Arizona, consist of crystals united by their prismatic faces and therefore resembling simple crystals. These groups of three crystals sometimes enclose a hollow triangular space running longitudinally through the center of the group. In a lot of *wulfenite* crystals from the Red Cloud mine in Yuma county were found a few tronis with the composition plane ∞P. They produce elbow shaped forms with the two limbs bent at right angles to each other. Fine *quartz* and *epidote* crystals, all of the latter of which are twinned parallel to ∞P occur in pockets in a peculiar rock composed of epidote, calcite and pyroxene, overlying a stratum of limestone at Calumet, Col. Some new facts are stated regarding the *phenacite* from Mt. Antero, and a new locality for the mineral is mentioned as existing half a mile distant from the locality already known. In the second place, the phenacites have a rhombohedral habit in consequence of the development of a rhombohedron of the third order. The pocket in which these crystals are found contains also many Baveno twins of white microline upon which most of the phenacite was implanted.—The *feldspar* of the nepheline and lencite basamites of Kilimandjaro examined by Fletcher a year or so ago[1] has been re-examined by Hyland[2]. The fresh mineral is pearl-gray in color, with a light vitreous lustre. Crystals containing the faces oP, ∞P ∞ are twinned parallel to ∞P$\breve{\infty}$, with this face also as the combination plane. In some of these an interior, twinned nucleus is surrounded by a zone of untwinned material, which can be removed from the former by

[1] AMERICAN NATURALIST, 1888, p. 930.

[2] Geological Magazine, April, 1889, p. 160.

mechanical means so as to leave a kernel with the shape of a Carlsbad twin. The cleavage of the mineral parallel to oP and ∞I' $\breve{\infty}$ are inclined to each other at an angle of 90° 3′. Between crossed nicols plates cut parallel to oP show twinning lamellæ of variable breadth extinguishing at 1°—3½°. Sections parallel to ∞ P $\breve{\infty}$ possess an extinction of 5°—6°. A chemical examination of purified material gave:

SiO_2	Al_2O_3	CaO	K_2O	Na_2O	H_2O	Sp. Gr.
61.35	23.10	3.02	5.34	7.11	.09	2.63

Its composition corresponds to $An_1\ Or_{2.1}\ Ab_{4.02}$. Since the mineral is undoubtedly triclinic Hyland would call it *soda microcline* as suggested by Brögger.—Intermingled with a few notes on new occurrences of minerals in Pennsylvania and New Jersey, Mr. Eyerman[1] records the analysis of *calamine* from Friedensville, N. J., and of *apophyllite* from St. Peter's, Chester Co., Pa., as follows:

	SiO_2	Fe_2O_3	ZnO	CaO	K_2O	H_2O
Calamine,	24.32	2.12	65.05			7.86
Apophyllite,	51.63			25.42	6.25	16.58

—The same writer[2] describes large crystals of *pyrite*, *chalcopyrite*, *apophyllite*, *stilbite*, *garnet* and smaller crystals of *calcite*, *orthoclase*, *pyroxene*, *aragonite*, masses of *pyrallolite* and *erythrite* and needles of *byssolite* in calcite, all from the shafts of a magnetic mine at French Creek, Pa. The stilbite gave on analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	H_2O
58.00	13.40	tr.	7.80	1.40	1.03	tr.	18.30

—Abnormally developed crystals of *pyrite* from these mines are mentioned by Mr. Penfield[3] as being lengthened in the direction of one of their axes as to present tetragonal symmetry with all the planes terminating at the extremity of the extended axis curved. The crystals are either simple octahedra or octahedra in combination with pyrotoid faces. It is thought that the abnormality may be due to the development of the planes of the form ½ O.—Crystals of *gypsum* from the salt marshes of Batz, Loire-Inférieur, France, are so associated

[1] Notes on Geology and Mineralogy, Proc. Acad. Nat. Sci., Phila. Feb. 26, 1889, p. 32-35.

[2] On the Mineralogy of the French Creek Mines in Pennsylvania. Read before the N. Y. Acad. of Sciences, Jan. 14, 1889.

[3] *Amer. Jour. Science*, March, 1889, p. 209.

with iron pyrites and organic calcium carbonate, as to leave no doubt[1] that they have been produced by the action of these two substances upon each other.—Messrs. Clark and Catlett[2] have discovered small quantities of platinum in a mass of sulphide of nickel, iron and copper from the copper mines at Sudbury, Ontario. The principal sulphide in the mass is the rare mineral *polydymite* $(NiFe_4)S_6$.—Mallard[3] has measured the index of refraction for yellow light in the rare mineral *sellaite* from the vicinity of Montiers, and finds $\varepsilon = 1.389$ and $\omega = 1.379$.—Cruciform twins of *thenardite* from Borax Lake, Cal., are stated by Mr. Ayres[4] to have $P\bar{\infty}$ as their twinning plane.—Jannash and Calb[5] have analyzed a large number of specimens of tourmaline, and have reached the same conclusion with reference to the composition of the mineral as was reached by Riggs[6] about a year ago.

PSYCHOLOGY.

THE SENSE OF SMELL IN DOGS.—Under this title Dr. George J. Romanes read a paper at the meeting of the Lumean Society of London, December 16, 1886. After preliminary observations on the faculties of special sense generally, and in particular that of smell, as enormously developed in Carnivora and Ruminantia, the author related his own experiments with a setter bitch. His conclusions are that in the case of this animal she distinguished his trail from that of all others by the peculiar smell of his boots, and not by the peculiar smell of his feet. "No doubt the smell which she recognized as belonging distinctively to my trail, was communicated to my boots by the exudations of my feet; but these exudations required to be combined with shoe leather before they were recognized by her. Moreover, it may be inferred that if I had always been accustomed to hunt without boots or stockings she would have learned to associate with me a trail made by my bare feet. The experiments further show that although a few square millimetres of the surface of

[1] Bull. d. l. Soc. Franc. O. Min., xi., p. 295.
Amer. Jour. Sci., May, 1889, p. 372.
[3] Bull. Soc. Franc. d. Min., xi., p. 302.
[4] *Amer. Jour. Science*, March, 1889, p. 235.
[5] Ber. d. deutsch. Chem. Ges., 1889, p. 216.
AMERICAN NATURALIST, 1888, p. 250.

one boot is amply sufficient to make a trail which the animal can recognize as mine, the scent is not able to penetrate a single layer of brown paper. Furthermore, it would appear that in following a trail this bitch is ready at any moment to be guided by inference as well as by perception, and that the act of inference is instantaneous. Lastly, the experiments show that not only the feet (as these effect the boots) but likewise the whole body of a man exhales a peculiar or individual odor, which a dog can recognize as that of his master amid a crowd of other persons; that the individual quality of this odor can be recognized at great distances to windward, or, in calm weather, at great distances in any direction; and that this odor is not overcome by anise seed."—*Zool., Anz.*, No. 242.

MIND AND CONSCIOUSNESS.—*To the Editor of the Open Court:* You and Mr. Hegeler have expressed the desire (in a letter, December 31, 1887), to know how it happened that in my friendly contention with Professor Cope I have used "consciousness" and "mind" synonymously. I did so partly out of courtesy to my adversary, who habitually makes use of the phrase "mind or consciousness," and partly to carry on the discussion as much as possible on the basis given by himself.

Allow me, however, to indicate as briefly as possible how I myself distinguish "consciousness" from "mind." "Consciousness" is that state of our being in which we are aware of what is usually classified as sensations, perceptions, emotions, thoughts and volitions. When we are thoroughly asleep or in a swoon we are not aware of such affections, and are consequently not conscious.

Consciousness, of course, can be only a *present* phenomenon, a manifestation taking place within us *at the very moment.* When we are conscious of something that has occurred in the past, this retrospective consciousness takes place likewise only in the moment of present awareness. The same holds good with prospective consciousness. We foresee the future only as content of our present consciousness.

I have called this one, all-comprising moment of conscious realization "the mental presence," and have repeatedly pointed out that its contents vanish from moment to moment into nothingness, and are as constantly reconstituted under kaleidoscopic changes, from a persistent vital matrix. Con-

sciousness is always the effect or outcome of some underlying *activity*, never itself the manifesting substrate.

The underlying vital matrix is perceived by us as the nerve-system of organic beings. And *all* the functional activities of this nerve-system contribute toward the production of the mental presence, though many phases of it may remain unconscious; and this not only from their not attaining a sufficient degree of intensity, but also by dint of normal disposition (see "Space and Touch," *Mind*, No. XL.).

When the term consciousness is used collectively for a series of mental states which we experience during an hour or a lifetime, it does not denote an actual phenomenon or veritable existent, but stands merely as a general name, in the same way as "animal" or "plant."

The term "mind" signifies to most persons some active immaterial agent within us, capable of producing or manifesting conscious states. As I do not believe in such an agent, I can rightly speak of mind only adjectively, as when I say: "mental states," and then "mental" is really synonymous with "conscious." Or I can speak of it, at most, as an attribute of our being, as when I say, "our mentality," which is not synonymous with our "consciousness," as it includes also the unconscious working of the brain toward the production of consciousness.

We can, moreover, not well avoid using the term "mental" as an opposite to "physical." This distinction is felt by every one to be legitimate. Yet it is incontestable that everything physical—all matter and all motion—is realized by us solely as perception of our own. We become aware of it as a peculiar kind of conscious event within our own mental presence. A physical fact is, consequently, itself of mental consistency, for it forms part of our own consciousness. And the only essential difference between it and other constituents of our consciousness lies in the fact of its being aroused in us through compulsory sense-stimulation, while other conscious states arise in us without any compulsory influence working upon us from outside our own being.

To become, however, fully alive to the radical contrast obtaining between what we call a "physical" and what we call a "mental" fact, we need only realize that mental facts, as such, are entirely imperceptible through sensory channels, while it is the very characteristic of physical facts to be thus perceptible. I can touch your physical being, hear your voice, and

see your body move and gesticulate; but I cannot touch, hear or see any of your sensations, perceptions, emotions, thoughts or volitions. These are inwardly or retrospectively realized by yourself alone.

The distinction here established is essential. It excludes, first of all, the possibility of our entire being consisting of mind stuff, as believed by Idealists of all shades. And it excludes also the possibility of anything mental being in the remotest degree akin to physical forces, as taught by materialistic thinkers, for no one can deny that we give the name of "force" only to that which is capable of affecting our senses in some way or other, and this is exactly the kind of effect that nothing purely mental can produce.

Yours, very truly,

EDMUND MONTGOMERY.

The Open Court.

GEOGRAPHY AND TRAVEL.

ASIA.—FORMOSA.—Mr. G. Taylor, an Englishman in the Chinese Lighthouse Service, gives in the April issue of the *Proceedings of the Royal Geographical Society* a most interesting account of the natives of Formosa. There was considerable difficulty in establishing a lighthouse at the southern end of the island, among wild natives inimical to Chinese rule, but at last the ground for its erection was fairly bought, and this commencement without bloodshed led to future amicable relations. The Chinamen has ousted the natives from the fertile and highly cultivated plains of the west and north, and even in the south the Chinese squatter has fixed himself upon all the streams, so that the really wild natives have had to retreat to the mountains, especially as many of the native races adopt Chinese customs, settle down, and cultivate the ground.

Formosa possesses only two harbors worthy of the name, viz., Keelong in the north, and Takowin in the west. The first of these can be entered by larger vessels, but the second has the advantage of being more entirely land-locked. The entire island is densely wooded.

There is little doubt that the original settlers were Malay, but physiognomy differs greatly in the same tribe. At present there are four principal races who have preceded the Chinese, viz., the Paiwans, Tipuns, Amias, and Pepohoans.

The Paiwans seem to have been the first settlers, and some are still head hunters, no youth among the wild tribes finding favor with a girl unless he can show a head as a trophy. The Paiwans are a tall, fine-limbed active race of mountaineers, and the women, although small, are symmetrically formed. Their dress consists of nothing but two aprons, one in front and one in rear. Drunkenness is the prevailing vice of the tribe, and has already sapped the power of Paiwan rule in South Formosa.

The Tipuns seem to have come from the north, perhaps from Japan. They must have had considerable civilization when they came, as they were the ruling people in South and East Formosa before the advent of the Chinese. In person they are rather shorter than the Paiwans, less angular, and more inclined to become fleshy. They wear leggings, waist cloths, and long overcoats of buff skin, are an agricultural people, can work in iron and silver, and often intermarry with the Chinese. They have a language of their own, but also speak the tongue of the Paiwans, with whom they are to a considerable extent merged. Pilam, where they first landed, was once the capital, and Tipun headmen were sent to the Paiwan villages. But afterwards the Southern Paiwans, led by some exiled chiefs of the Tipuns, rebelled, and established their independence.

The Amias hold among the natives a lower rank, though they are more muscular and hirsute. They divide time into years, and hold their new year at the end of harvest. There is a tradition among them that they once had written characters, but no traces of these exist.

The Pepohoans seem to be a mixed people, and have a higher civilization than the other tribes. Chinese stories make fun of their simplicity, but intercourse with the Chinaman has given them his astuteness.

The young men of the Formosan natives live in a separate house called a padangkan, as in some African tribes. When a young man has obtained the consent of a girl, he leaves at the door of the parents a bucket of water and some wood. If they agree to the match, the wood and water are taken in, but if not, the lover has still undisturbed possession of his lady love if he can induce her to elope with him.

The Paiwans bury their dead in a spot near his dwelling; the grave is lined with stone, the clothes, arms and ornaments of the deceased are buried with him, and the corpse is placed sitting, facing the nearest high mountain. The grave is then filled up and turfed over. The Tipuns have similar burial customs, but bury within their dwellings. Among the

Tipuns tattooing is practiced upon wrists, etc., but it is a privilege of nobility.

The Amias bury in waste ground, the corpse facing the west; they erect a wooden slab over the spot, and each mourner throws a handful of earth at the grave, and spits at it, repeating a formula telling the dead man that he has been properly treated, and had better stay quietly where he is, or, should he come back, he will be stoned and spit upon.

All the natives are full of superstitions about goblins, etc. They believe that thunder is made by the male divinity throwing things about, and that the lightning is caused by the female uncovering herself. A female uncovers herself if she is evincing the utmost scorn. Some of their stories are about animals assuming human forms.

The Koahuts (a tribe of Paiwans) build neat houses of bamboo covered with straw. The southern Paiwans of Tierasock construct huts of sun-dried bricks, and cover them with thatch. The coast Paiwans are cleanly; they wash and scrub all utensils with sand every morning, and they eat their food with spoons made from a pearly shell. The Tipuns and Amias are scarcely so well housed, nor are they as clean. A Tipun chooses a tree as the centre of his house, and builds around it an irregular hut with partitions. The Tipuns have no tables or spoons; they squat on a billet of wood and dip their hands into a common dish. But the wild Paiwans of the mountains live in a hole dug upon a hillside, and fronted with slabs of slate. When it becomes too filthy to be longer endurable they dig a new hole.

The irrigation practiced by the Chinese has doubtless injured various creeks and harbors, but the island seems to be rising. Anping was an island at the time of the Dutch, but is now joined to the mainland; and an anchor has at another spot been found several feet below ground.

It does not seem that any of the tribes now practice cannabalism, but the coast Paiwans accuse their brethren of the hills, and tell a story of a chief of the Diaramocks who served up his son as a choice morsel to the ambitious chief Tokotok, who aimed to unite all Formosans under his sway.

AFRICA.—THE ZAMBEZI-CONGO REGION.—Rev. F. S. Arnot (*Proc. Geog. Soc., London*, 1889. 11) gives an account of his journey from Natal in search of an elevated spot upon the water-parting between the Zambezi and the Congo, suit-

able for the establishment of a mission. He traversed the Kaohavi and the district of the Bamangwak, but was turned back by Liwanika, chief of the Barotse. He then retreated toward Benguela, but set out again and reached the country of the Gavenganze. Ascending plateux of 4000 to 6000 feet he arrived at Kwanza, and soon after discovered that the great depression Kifumadji, which Cameron believed to be a lake, has no water (save Lake Dilolo) except in the wet season. Then leaving the Upper Zambezi on the right, the traveller entered a mountainous country, where Mount Kaomba form a water-parting between the Congo and the Zambezi. He was favorably received by Msidi, chief of the Gavenganze, and lived there some years before his return. Ivens and Capello had previously visited Msidi. Mr. Arnot says that Livingstone's Leeba is the true source of the Zambezi.

MR. SELOUS' JOURNEY IN THE ZAMBEZI COUNTRY.—F. C. Selous sends an account of his recent and somewhat unfortunate journeys in Africa, accompanied by a sketch map, to the *Proceedings of the Geographical Society*, London. It was Mr. Selous' intention to explore the Kafukwe, an important tributary of the Zambezi from the north, and at first all went well. Monze, the Mashona chief, had seen no white man since Livingstone passed thirty-five years since, and spoke of that event as though it had been last year. With the Mashakalumbwe, a people on the Kafukwe who have no firearms and wear no clothes, but who never go out without a bundle of long, barbed throwing javelins, Mr. Selous had great difficulty, and narrowly escaped with his life. These people, aided by some Marotse, or inhabitants of the Barotse valley, attacked the camp in the night, and by a volley killed twelve and wounded five of his escort. Mr. Selous escaped, and, after having his rifle stolen, and after enduring great hardships, fell in with the remnant of his party. The Barotse valley is a hot-bed of fever, and no white man can hope to escape death if he continues in this part of Africa.

EUROPE.—THE CAUSSES OF THE SOUTH OF FRANCE.—E. A. Martel contributes to a recent issue of the *Revue de Geographie* an article upon the *Causses* of the South of France, a region almost unknown ten years ago, and not rightly known till now. These Causses are calcareous plateaux, not dissimilar in their nature to the mesas of the Colorado region, and

evidently formed as a sediment at the bottom of the secondary sea. These Causses, the highest portion of which rise 1,200 metres above the sea, have, in the course of time become furrowed by canons 400-500 m. in depth. There are four principal Causses and numerous smaller ones. These four, commencing at the North, are: the Causse Sauveterre, which is the least sterile of all; the Causse Mejean, the most arid, elevated and isolated, having an area of 400 sq. kil., and united to another Causse only by an isthmus, which is, in some cases, not more than 10 m. wide; the Causse Noir, which is the smallest and most picturesque of the large Causses; and the Causse Larzac, largest of all, with an area of 1,400-1,500 sq. kil. All these Causses are bare, dreary, monotonous deserts, without water and almost without inhabitants. The rivers that separate them have no above-ground affluents, but are fed by powerful springs and streams that flow from the junction of the limestone with the clay beneath, at the level of the bottom of the gorges. The rains penetrate the limestone at apertures which are called *avens*, sink until they reach the bed of clay and have underground courses sometimes of considerable length. Exploration of the caverns is, however, very difficult, and, indeed, impossible, except to those provided with proper apparatus. M. Martel traced the course of a stream, the disappearance of which had long been a problem to the natives, and discovered two caverns, one of which, Dargilan, has a length of 2800 m. with many large halls, one 190 m. long, and is, in many respects, a rival to the celebrated Grotto of Adelsberg, especially as it has the finest stalactites in Europe.

The finest gorge is that of the Tarn, which for 80 kilo. flows in the depths of a cañon, the walls of which have a mean height of 500 m. One of the greatest wonders of the region is Montpellier-le Vieux, a promontory of triangular shape upon the Causse Noir, above the valley of the Doubré which is here 400 m. deep. At this spot 1000 hectares are covered with what seems like the ruins of a city with its streets, squares, monuments, etc. M. Martel's description recalls the Garden of the Gods and other spots in Colorado.

BOTANY.[1]

THE FLORA OF THE UPPER NIOBRARA.—In the northwestern part of Nebraska there are conditions which have given rise to a flora which possesses unusual interest to the student of botanical geography. Here a spur of the Rocky Mountains extends eastward between the headwaters of the Niobrara River on the south and the White River on the north. This extension of elevated land bears the local name of Pine Ridge. It rises above the great plain as a series of higher and higher ridges and points, until at its culmination it is fully twelve or fifteen hundred feet above the general level to the north and the south. Its southern slopes are less abrupt, but upon its northerly side it is often very abrupt and broken, and here there are multitudes of picturesque and fantastically shaped buttes.

Both the Niobrara and the White Rivers, in this region, run through rather broad flood plains, but their tributaries are all cañon streams, often with high rocky precipices along their banks. Here and there fine springs burst from the sides of the cañons, and give rise to clear, cold streams of pure water. These are more numerous upon the northerly side than upon the south. The elevation of the summit of the ridge is nearly five thousand feet above the sea. The tunnel of an extension of the Chicago, Burlington & Quincy Railway passes through the ridge at a measured elevation of four thousand five hundred feet, and there are numerous points within a short distance which rise fully three or four hundred feet above it.

The vegetation of this region presents an interesting mingling of the Rocky Mountain and the eastern floras. Its most striking feature is the abundance of pine trees. These are all of the Rocky Mountain variety of the Great Yellow Pine of the Pacific Coast. *Pinus ponderosa* var. *scopulorum*. They attain a height of from fifty to eighty or ninety feet, and have often a diameter of from fifteen to twenty-five or more inches. They occur in heavy masses in the cañons, and in more scattered growths upon the slopes and hilltops. So important are these pine forests that many saw mills have been erected near them, and large quantities of lumber have been cut for use in railroad construction and for other uses. Other trees occur only in the cañons. The most important of these are *Negundo aceroides, Prunus Americana, Prunus demissa, Fraxinus viridis.*

[1] This department is edited by Professor Charles E. Bessey, Lincoln, Neb.

Ulmus Americana, Populus monilifera. Occasionally one may find a tree of *Juniperus virginiana*, and on Crow Butte there are numerous specimens of *Juniperus communis* var. *alpina*. Of the lesser woody plants one finds *Celasteus scandeus* in abundance, though far out of its reputed range. *Vitis ripania* and *Ampelopsis quinquefolia* are common, as are, also, *Rhus glabra*. *R. toxicodendron* and *R. aromatica* var. *trilobata*. Here we find growing commonly the yellow flowered currant, *Ribes aureum*, the Buffalo Berry, *Shepherdia argentea*, and the Diamond Willow, *Salix cordata* var. *vestita*.

Of the herbaceous vegetation only the following need be enumerated: *Thermopsis rhombifolia; Lupinus plattensis; Latteyrus polymorphus; Potentilla anserina; Œnothera albicaulis; Gaura coccinea; Opuretia missousiensis; O. fragilis; Campanula rotundifolia; Asclepias speciosa; Gilia lineasis; Heliotropium convolvolaceum; Krynitzkia glomesata; Yucca augustifolia; Calochostus nuttallii; Stipa spartea; Buchloe dactyloides; Munsoa squanosa; Boutelona oligostachya.* In addition numerous species of *Astragolus, Estsgonum*, and of various mountain composites might be noted, but those already given are perhaps sufficiently characteristic.—*Charles E. Bessey.*

KELLERMANN AND SWINGLE'S KANSAS FUNGI.—Fascicle II. of this distribution has been received. It is fully as satisfactory as its predecessor. The numbers are as follows: No. 26. Æcidium callir hœs E. & K.; 27. Æ. grossulariæ Schum.; 28. Æ. penstemonis Schw.; 29. Æ. pustulatum Curt.; 30. Æ. tuberculatum E. & K.; 31. Cæoma nitens Schw.; 32. Cercospora althæina Sacc.; 33. C. diantheræ E. & K.; 34. C. Juglandis Kell. & Sw.; 35. C. polytæniæ E. & K.; 36. C. tuberosa E. & K.; 37. Dendryphium subsessile E. & E.; 38. Entyloma physalidis Cke.; 39. Fusicladium effusena Wint.; 40. Glorosporiam nervisequum Sacc.; 41. Peronospora androsaces Neissl.; 42. Phyllosticta ipomœas E. & K.; 43. Puccinia nigresceus Peck; 44. P. schedonnardi Kell. & Sw.; 45. P. silphii Schw.; 46. Ramularia urticæ Ces.; 47. Srptoria tenella Cke & Ell.; 48. Uromyces graminicola Burrill; 49 U. hyalinus Peck; 50. U. polygoni Fckl.

BAILLOU'S DICTIONNAIRE DE BOTANIQUE.—This work has now reached the 24th fascicle, the latter extending from *Lise* to *Meri*. Among the topics which have notable treatment, either by text or engravings are *Lycopodium, Magnolia,*

Marchantia and *Melastoma*. The accompanying colored plate represents a twig bearing leaves, fruit and seed of *Theobroma cacao*, the chocolate tree of full size. The fascicles contain about 80 pages, and are of quarto size. Among the collaborators are Dr. Seynes, Nylander, Dutailly, Weddell, Durand, besides many other specialists.

LUERSSEN'S PTERIDOPHYTA.—In 1884 the first part of Luerssen's work on the Pteridophytes of Germany appeared, and recently part 14, which completes the volume, has come to hand. The work constitutes Vol. III. of the new edition of Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz. The treatment of the subject is eminently satisfactory, the text being full, and the illustrations numerous and of fine quality. Some estimate may be made of the fulness of the work when the reader learns that for the eighty-eight species described, we have here a volume of no less than 906 pages.

Luerssen's system is as follows:

CLASS I. FILICINAE Prantl.

Sub-Class I. Isosporeae Sachs.

Section I. Leptosporangiatæ, Goebel.

ORDER I. FILICES L.

Sub-Order I. Hymenophyllaceae Bory.
Family 1. *Hymenophylloideae* Pr.

Sub-Order II. Polypodiaceae Martius.
Family 1. *Polypodieae* Meth.
Family 2. *Aspleniaceae* Meth.
Family 3. *Aspidiaceae* Meth.

Sub-Order III. Osmundaceae Brongu.
Family 1. *Osmundaceae* Brongu.

Section II. Eusporangiatae Goebel.

ORDER II. OPHIOGLOSSACEAE R. Br.
Family 1. *Ophioglosseae* R. Br.

Sub-Class II. Heterosporeae Sachs.

ORDER III. HYDROPTERIDES Willd.
Family 1. *Salviniaceae* Bartl.
Family 2. *Marsiliaceae* Bartl.

CLASS II. EQUISETINAE Prantl.

ORDER IV. EQUISETACEAE Rich.
Family 1. *Equsietaceae* Rich.

CLASS III. LYCOPODINAE Prantl.

Sub-Class I. Isosporeae Prantl.

ORDER V. LYCOPODIACEAE Rich.
Family 1. *Lycopodiaceae.*

Sub-Class II. Heterosporeae Prantl.

ORDER VI. ISOÖTACEAS Bartl.
Family 1. *Isoötaceae* Bartl.

ORDER VII. SELAGINELLACEAE Meth.
Family 1. *Selaginellaceae* Meth.

Our familiar *Pteris aquilina* L. becomes under Luerssen's treatment, *Pteridium äquilinum* Kuhn. So too *Aspidium filix-femina* Sw., the *Asplenium filix formina* Beruh., of the ordinary manuals, becomes *Athyrium filix formina* Roth.—*Charles E. Bessey.*

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

PHILADELPHIA ACADEMY OF NATURAL SCIENCES.—April 24, 1888. Professor Ryder spoke of the displacement of the nucleus of tissue cells and in ova by a large amount of yolk matter.

May 1, 1888. Professor Leidy called attention to some *Menopon perale*, and also spoke of the parasites of the rock-fish.—Mr. Meehan exhibited specimens of the so-called navel orange.—Professor Wilson described some ærial roots in corn caused by abnormal watering of the plant. May 9, 1888. Professor Leidy spoke of the parasites of the pike and the pickerel.—Dr. Meyer described a tertiary barnacle, *Balanus concavus*, occurring in the neighborhood of Norfolk, Va. May 15, 1888. Dr. McCook read a description of four new species of orb-weaving spiders. He also made a communication on the color of spiders. May 29, 1888. Mr. Wilcox called attention to a number of shells beveled and perforated to permit a stick being thrust through for a handle.

June 5, 1888. Professor Heilprin called attention to a col-

lection of specimens obtained from a deep boring at St. Augustine, Fla.—Dr. Chapman described the generative organs of a female spotted hyena from South Africa.—Mr. Meehan spoke of the importance of studying the companionship of plants, and announced the discovery of *Trientalis americana* in the vicinity of Philadelphia. June 12, 1888. Dr. McCook read a description of *Evatypus woodwardii*, a fossil spider. June 19, 1888. Professor Heilprin discussed the age of Laramie. June 26, 1888. Dr. McCook gave a résumé of a paper on the purse weed spiders.—Professor Ryder described the eggs of the sturgeon.

July 3, 1888. Dr. Koenig described some crystals of magapilite.—Mr. Meehan spoke of the so-called flowers of Hydrangea. July 10, 1888. A communication from Dr. Leidy on the fauna of Beach Haven, and on the embryology of *Lepas fasciularis*, was read.—The chairman exhibited a fine specimen of the snow plant.

August 7, 1888. Mr. Meehan spoke on the sexes of flowers.

September 4, 1888. Mr. Meehan and others discussed the polarity of the compass plant.

October 2, 1888. Professor Leidy called attention to the claw of a giant sloth found in the drift in Mills County, Ind., and exhibited a portion of a human skull having four true molars. October 9, 1888. Professor Heilprin made some remarks on the classification of the tertiary deposits. October 16, 1888. Mr. Redfield called attention to a probable hybrid Solanum.—Dr. Morris alluded to the effects of insect bites.—Dr. McCook read a paper on *Lycosa arenicola*. October 23, 1888. Professor Heilprin spoke of the physiography of the Bermuda Islands. October 30, 1888. Professor Heilprin discussed the Bermuda coral reefs.

November 6, 1888. Professor Heilprin described the fauna of Bermuda Islands November 13, 1888. Professor Heilprin continued his remarks on the zoology of Bermudas. November 20, 1888. Professor Ryder presented the results of his study of the skeleton of living forms.—Dr. McCook described a case of double cocoonizing in *Argiope riparia*.—Dr. Rushenberger read a biographical notice of the late George W. Tryon.—Dr. Leidy read a communication on the zoology of Beach Haven.

December 4, 1888. Dr. Morris and others discussed the color of glass due to exposure to heat and air.—Mr. Ives de-

scribed two new forms of star-fish.—Mr. Morris read a paper on subsidence. December 11, 1888. Dr. McCook read a paper on nomenclatures of spiders.—Professor Ryder gave the results of his study of *Mya arenaria*. He also exhibited and described a section of the skin of an elephant. Professor Leidy spoke of the embryology of Lepas. December 18, 1888. Mr. Pilsbry called attention to anomalies in *Helix bermudensis*.—Dr. Foote spoke of Threnardite.—Mr. Morris read a communication on colored glass.—Professor Heilprin summarized the observations made by the recent Greenland expedition.

January 1, 1889. Dr. Koenig exhibited and described a specimen of Anhydrite.—Dr. Leidy discussed the Gregarines. January 8, 1889. Professor Ryder made a communication on the axial skeleton.

February 12, 1889. Professor Ryder read a paper on the development of the calcified skeleton of Chelonians. February 19, 1889. Dr. Leidy described some teeth of a fossil horse from a limestone quarry in Florida.—Mr. Ives reported finding on the omentum of a monkey a number of Pentastomum.

March 5, 1889. Dr. Horn referred to the incrustation of fragments of wood by the mineral constituents of water or soil. —Dr. Leidy exhibited two spiders from Peru, and stated that the tooth of a fossil Llama, from Florida, had been received. March 12, 1889. Dr. Leidy read a paper on Cliona. March 19, 1889. Dr. Brinton exhibited a specimen of *Chrysosplemium americanum*.—Professor Ryder discussed the question of mammalian descent.—Dr. Rex exhibited a specimen of an undersized trichia from Montana.—Dr. Brewer exhibited specimens of yeast and described the development of its cells. —Mr. Wingate exhibited and described a new myxomycete.— Mr. Ives gave a résumé of a paper on "Variation of Color in Star-Fish." March 29, 1889. Dr. McCook explained the structure of spider webs.

April 2, 1889. Dr. Koenig described some Kansasite from Kansas.—Mr. Woolman called attention to the micro-geology of Atlantic City.—Professor Heilprin spoke of the geology of Bermuda and the structure of coral reefs.—Professor Ryder gave the development of vertebræ in certain lower forms.—A communication from Professor Wilson on the production of aerating organs on the roots of swamp and other plants was

read. April 9, 1889. Mr. Meehan made a communication on dogwood.—Mr. Ryder spoke further of his studies of the vertebral column. April 16, 1889. Dr. Hartzell exhibited a section of skin mounted in monobromide of naphthaline.—Professor Ryder commented on the homologies of the jaw of Acanthias in mammalian dentition—Dr. Rex spoke of the interest attaching to common molds and mildew. April 23, 1889. Mr. Wilcox recounted his own explorations of Florida with reference to the geology of that State.—Professor Leidy spoke briefly of the palæontology of Florida.— Professor Heilprin gave a résumé of his study of the fauna of the Bermudas—Mr. Ives described the ophiurans. April 30, 1889. Professor Ryder resumed the report of his study of the development of the vertebral column with especial reference to its growth in the sharks.

May 7, 1889. An invitation from the University of Pennsylvania to remove the building to West Philadelphia was read.—Mr. Meehan referred to his former communication on the formation of species of dog-wood as affected by the principles of acceleration and retardation.—Professor Wilson spoke of the relation of various vegetable substances to electric filaments as bearing upon electric illuminations.—Mr. Redfield detailed the nature of botanical travel one hundred years ago. —Professor Dolly offered some remarks on Bahama plants.— Professor Rothrock described the sand dunes of Lewes, Del. May 14, 1889. Mr. Pilsbry spoke of the modifications of the odontophores in the Rhipidoglossa.—Mr. Ford referred to a new species of Helix from New Guinea, and to a group of fossil olives from Florida.—Mr. Wilcox described the habits of *Fasciolaria gigantea* from Florida. Mr. Campbell exhibited specimens of the genus Cypræa illustrating the convergence of species.—Professor Ryder gave the results of his studies into the structure of the transparent tissues surrounding the eye of the common shad. May 21, 1889. Professor Ryder gave the substance of a paper on Volvox.—Dr. Rex spoke of the development of a species of myxomycetes, *Clathroptychium rugulosum*.—Dr. Wingate exhibited specimens of the genus Physarum. May 28, 1889. The following resolution adopted: *Resolved*, That the Academy, in accordance with the recommendation of the Council, declines to accept the proposition made by the Provost of the University to move the institution to West Philadelphia.—Professor Ryder recounted recent investigations of heterocercous fishes.—Mr. Wilcox stated that

eggs of Ampularia sent to Wagner Institute had all hatched out.

June 4, 1889. Professor Heilprin placed on record the finding of the first fossils in the limestone near Henderson Station.—Mr. Woolman exhibited a specimen of cretaceous limestone outcrop from the neighborhood of Clementown, N. J., full of *Trochosmilia atlantica.*—Professor Sharp described the extinct circular crater of St. Vincent.—Mr. Rand exhibited specimens of serpentine pseudomorph after asbestos, found near Radnor Station, and a variety of Iceland spar from Rossy Wene, N. J.—Mr. Jefferis exhibited a specimen of clinoclase from the Birmingham quarries. June 11, 1889. Dr. Horn exhibited a collection of beetles injurious to vegetation.—Dr. Skinner exhibited two rare papilios (*P. dasorada*) from Sikkim, India, and and an X butterfly from the Andaman Islands.—Dr. McCook made a communication in the sense of hearing of spiders. June 18, 1889. Professor Ryder described the larva of a species of salamander Amblystoma, which showed heterocercy. He also described the occurrence of hypertrophied hairs on the tips of the shoots of Ampelopsis.—Professor Sharp told of some carnivorous bats.—Dr. Rex exhibited a rare fructification of one of the black molds.—Dr. Hall called attention to aspergillus growth from a Brazil nut.—Mr. Wingate exhibited a box containing some enteridium.

BOSTON SOCIETY NATURAL HISTORY.—President, F. W. Putnam; Vice-Presidents, John Cummings, G. L. Goodale; Curator, Alpheus Hyatt; Honorary Secretary, J. C. White; Secretary, J. Walter Fewkes; Treasurer, Charles W. Scudder; Librarian, J. Walter Fewkes; and twenty-five Councilors.

The following papers were read: Mr. A. F. Foerste spoke of "The Palæontological Horizon of the Limestone Beds of Nahant."—Mr. J. E. Wolff read a paper on "Some Metamorphic Rocks in the Green Mountains.—Mr. A. F. Foerste then considered "The Fossils of the Clinton Group of Indiana and Tennesee."

BIOLOGICAL SOCIETY OF WASHINGTON—The following communications were read: January 26, 1889. Dr. Cooper Curtice, Notes on the Sheep Tick, *Melophagus ovinus* LINN.—Dr. Geo. Vasey, New Species North American Gramineæ of the Last Twelve Years.—Mr. Th. Holm, Contributions to the Morphology of the Genus *Carex.*—Dr. C. Hart Merriam, A new species of Pika (*Lagomys*).

February 9. The following papers were read: Mr. B. F. Galloway, Diseases of the Sycamore.—Dr. Thomas Taylor, A new Freezing Microtome.—Mr. A. A. Crozier, Influence of Foreign Pollen on Fruit.—Mr. J. N. Rose, Geographical Distribution of the Umbelliferæ.—Dr. C. Hart Merriam, A New and Remarkable Vole from British Columbia.

February 23d. Mr. E. M. Hasbrouck, A New Maryland Yellow-throat.—Mr. M. B. Waite, Notes on *Melampsora hydrangeæ* Lusk. Notes the Seed Vessels of the Lop Seed *Phyrma leptostachya*.—Mr. Chas. D. Walcott, The Genus Olenoides of Meek.—Dr. R. L. Stejneger, Notes on Pallas' Cormorant.—Mr. F. V. Colville, The Fruit of *Stipa spartea*.—Dr. C. Hart Merriam, A New Marmot from the Sierra Nevada.

March 9.—Mr. Geo. B. Sudworth, Variations in the genus *Quercus*.—Mr. W. B. Barrows, Dangerous seed-planting by the Crow.—Dr. C. Hart Merriam, A new Ground Squirrel from the Southwest.—Mr. Chas. D. Walcott, The Genus *Olenellus* of Hall.

March 23. Dr. W. H. Seaman, Our Present Knowledge of the Rotifers.—Mr. C. L. Hopkins, A Point of Definition.—Mr. Geo. B. Sudworth, Variations in the genus *Quercus*.—Mr. W. H. Dall, Reproductive Organs in Certain forms of Gasteropoda.

April 20. Prof. Joseph F. James, The Effect of Rain on Earthworms.—Mr. F. W. True, The Occurrence of Sowerby's Whale on the Coast of New Jersey.—Mr. Theo. Holm, The Germination of Sarracenia, Rheum, Peltandra, Hemerocallis and Cyperus.—Dr. C. Hart Merriam, A new Vole from the Gulf of St. Lawrence.—Mr. Geo. B. Sudworth, The Influence of Odor in Attracting Insects.

May 4. Mr. W. T. Hornaday, Exhibition of a Specimen of the Black-footed Ferret (*Putorius nigripes*).—Mr. B. E. Fernow, Annual Ring-Growth.—Dr. Theobald Smith, Parasitic Prozotoa (*Coccidia*) in the Renal Epithelium of a Mouse.—Dr. H. E. Van Deman, Tropical Fruit of the Lake Worth Region.—Dr. C. Hart Merriam, A new Spermophile from Arizona.

May 17. Dr. C. Hart Merriam, Two new Spermophiles from the Lower Colorado, with remarks on the Importance of the Type Locality in the Study of Species.—Dr. Cooper Curtice, How Entozoa Cause Disease.—Mr. Frederick W. True, Exhibition of a Skull of a Female Narwhal with two well developed Tusks.—Mr. L. O. Howard, Notes on Spider Bites.—

Mr. C. D. Walcott, Description of New Genera and Species of Lower Cambrian Fossils.

WICHITA ACADEMY OF SCIENCE.—On Saturday, April 6th, 1889, the Wichita Academy of Science was organized, having for its object "to promote the study of science and stimulate original investigation." The officers elected for the ensuing year are as follows:

President, J. M. Naylor, A.M.; 1st Vice-President, M. E. Crowell, A.B.; 2d Vice-President, W. A. Crusinberry, A.M.; Recording Secretary, J. S. Foote, M.D.; Corresponding Secretary, Fred L. Johnson, M.D.; Treasurer, F. J. Ford; Curator, E. L. Kemp, A.M.; Librarian, F. L. Hinsdale, M.D.

Regular meetings are to be held on the first Saturday of each month.

THE KENT SCIENTIFIC INSTITUTE, GRAND RAPIDS, MICH.—The following is the list of the officers for 1889:

President, E. S. Holmes; Vice-President, W. A. Greeson; Recording Secretary, C. W. Carman; Corresponding Secretary, E. S. Holmes; Treasurer, C. A. Whittemore; Director of the Museum, W. A. Greeson; Curator, C. W. Carman; Librarian, E. L. Moseley. Board of Directors: Wright L. Coffinberry, W. A. Greeson, Samuel L. Fuller, E. S. Holmes, J. W. Jones, C. A. Whittemore. Officers of the Board: Chairman, W. A. Greeson; Secretary, E. S. Holmes; Treasurer, C. A. Whittemore.

CHICAGO ACADEMY OF SCIENCES.—A regular meeting of the Academy was held in the Art Institute, Michigan Boulevard and Van Buren Street, March 12th, at 8 o'clock. The evening was devoted to a conversation on the "Great Glacial Moraine at Lombard, Illinois," as examined by the Academy, at the excursion in June, 1888.

NATURAL SCIENCE ASSOCIATION OF STATEN ISLAND.—Nov. 10th, 1888. This being the annual meeting, officers for the ensuing year were elected as follows: President, L. P. Gratacap; Treasurer, Samuel Henshaw; Recording Secretary, K. B. Newell; Corresponding Secretary, Arthur Hollick; Curator, W. T. Davis.

December 8th. Mr. L. P. Gratacap read the following paper upon the "Relation Between the Growth and Form of Leaves:"

It is obvious that the form of leaves must be the resultant of rates of growth in various directions. That a simple leaf with a single midrib will assume such a mature form as will express the equilibrium of the growing impulse along two axes, a longitudinal and a lateral one, and that as this ratio varies in favor of the first or the second, the leaf becomes ovate, circular, broadly elliptical, etc., or lanceolate, linear and elongated. And secondarily, in the case of the simple leaf, the point of intersection of the axis will modify the final form. If the lateral axis is developed at an early stage in the elongation of the midrib we have ovate leaves, if at a point half way along its length elliptical, if at the distal extremity obovate. And in leaves of a complex structure, whether palmate, pinnate or numerously veined with woody and rigid vascular fibres, we can resolve the entire form into a group of simple forms, wherein we may study the related rates of development in lamination (formation of parenchyma), and in vasculation (formation of ribs, veins, etc.). In other words, the rapid movement forward of rib cells would appear to interfere with or prevent the making of the leaf lamina, and their slow movement to assist it. In a leaf with several ribs, the slow progress of the rib-making permits the coalescence of the marginal tissues, and forms polygonal and crenate circular leaves, and also tends to introduce bifurcation and deliquesence of the original fibre bundles. In one, where the extension of the ribs is rapid, this coalescence is checked, and the leaf is sinuate, lobed, irregular and pinnatified.

It is thus apparent that a determination of the *actual* rate of growth in leaves may throw some light or be useful in assisting speculation as to the origin of leaf forms. And it is also apparent that there might be a condition of things exactly the reverse of our supposition given above, and yet produce the same result. That is, a linear leaf might be a, so to say, slowly made leaf as well as a quickly made leaf, if the movements of its parts maintain a ratio which gives extension in length and not in breadth. And in many cases of turgid and dense tissues in leaves this is probably so.

However the measurement of a number of leaf growths including those of Morning-glory, Musk-melon, Water-melon, Maples, *Magnolia*, Beach, Japanese Quince, Five Finger, etc., made this year on Staten Island, do seem to show that the elongated leaves grow much the more rapidly, that the palmate and pinnate leaves stand next in order, and the circular and

transverse leaves last. [A diagram was here presented showing these results in part, with the rate per day of growth, also the slowly diminishing rate of growth of the leaf as it approached completion.]

Of course a number of considerations occur at once to modify the wholesale use of this conclusion. The relative size of the leaves compared should be similar, the condition of healthfulness of the plants alike, the nature of the plant tissue nearly the same, and the position and aspect of the leaves, as regards favorable or unfavorable conditions for growth, identical. The subject is suggestive, and carefully followed up might lead to interesting results.

Mr. Arthur Hollick showed fossil leaf impressions in ferruginous sandstone, found near Arrochar Station by Mr. Gilman S. Stanton. They are undoubtedly from the same formation as those from Tottenville (Cretaceous ?) described in the Proceedings of December 8, 1883, and like them, were not in place where found, but occurred in Drift rocks. The specimens are too fragmentary for determination, but the fact of their discovery at this new locality is a matter of interest and is therefore placed upon record.

Specimens of bowlder clay from the same locality were also shown. It has been lately utilized for brick making. There is a fine exposure of modified drift, overlaid by bowlder drift, where the railroad has been cut through.

Dr. A. L. Carroll noted the discovery on Staten Island recently of *Bothryocephalus latus*—the first reported occurrence of this parasitic worm in America.

Specimens of the "Large Mocker Nut," *Hicoria alba*, (L.) Britton, *var. maxima* (Nutt., Britton.), were presented—being an addition to the local flora. They were collected by Dr. Britton near Court House Station.

February 9, 1889. Mr. Chas. W. Leng read a paper upon "The Buprestidæ of Staten Island," illustrated by specimens of the species mentioned.

It is thought that the larvæ of many species take years to perfect their growth, and an instance is recorded of a *Buprestis* emerging from the wood of a desk that had been in use for twenty years. One of our commonest species. *Chrysobothris femorata* is, however, said by Packard to complete its transformations in twelve months, so the usual period is uncertain.

This insect is found every year in numbers on oaks and

occasionally other trees. I took the greatest number about 1880, when Mr. Davis and I found a log near Silver Lake literally alive with them. They would take short flights and lighting on the log, hide in the crevices of its bark, which, by their color and deep-wrinkled furrows, they simulate to a degree. Many other species have this restless habit of flying from place to place, and on the wing look and buzz very like flies.

Two species of *Agrilus* are also abundant—*ruficollis* and *otiosus*—the first usually on wild blackberries and the second on a variety of young saplings. When the trees around Marling's Pond were cut down about three years ago, a growth of saplings sprang up on which the species of *Agrillus* were quite plentiful and besides many *otiosus* an occasional *bilineatus* or *interruptus* was found.

I have never found any of our other species in great numbers. Of the *Anthaxia* all my specimens have come from a clump of wild cherry in the Clove Valley. *Chalcophora* is said to breed in pine, but a good deal of beating has yielded little. The species have been found washed upon the beach and one specimen of *liberta* was taken by Mr. Davis flying at Watchogue. Two species of *Brachys* occur on the leaves of certain oaks, and I have found them in North Carolina in great numbers. Probably they will be found abundantly somewhere on Staten Island.

Chrysobothris azurea was a notable capture of 1886, and is everywhere counted a rare insect, but from May to July of that year it was plentiful on a species of dogwood in a thicket now burned over and turned into "Prohibition Park." The house, built, as I am told, for the dominie, stands just above where the first was taken. The beetles were very quick in their movements, and were captured by beating the trees over an umbrella, out of which they flew again as soon as they touched it. Several were observed resting on the main stems of the young trees with the anterior legs extended and the last ventral segment touching the bark and they were probably females depositing their eggs. None have been found since 1886, nor have I been able to find the larvæ in the few trees that are left.

Attention was called to the recent death of Mr. S. Elliot Lowell.

March 14, 1889.—Mr. L. P. Gratacap showed specimens of

fossils from a drift bowlder and gave the following account of the same:

Mr. C. S. Egbert in excavating a foundation for a house at Fort Wadsworth station on the Rapid Transit Railroad, on the north side of the Fingerboard Road, and a few hundred feet northeast of the station, uncovered a bowlder of Oriskany Sandstone which upon examination by Mr. Wm. T. Davis proved to be of great interest. It was a compact mass of fossils representing over twenty species characteristic of that horizon, of which fourteen were new to our list previously published (Extra No. 6, March, 1887.) Amongst these were some of considerable rarity, and while many were in a fragmentary condition or preserved as impressions only, they were all unmistakably identified, and form a valuable addition to our palæontological possessions.

The list of new additions is as follows:

Pholidops arenaria, Hall.
Streptorhynchus hipparionyx, Vanuxem.
Strophodonta magnifica, Hall.
Chonetes campalnatus, Hall.
Leptæna nucleata, Hall.
Spirifera pyxidata, Hall.
Leptocœlia flabellites, Conrad.
Eatonia peculiaris, Conrad.
Rennsselaeria ovoides, Eaton.
Pterinea Gebhardi, Hall.
" *textile*, Hall,
Aviculopecten rectirostris, Hall.
Platyceras nodosum, Conrad.
Platyostoma ventricosum, Hall,

Mr. Arthur Hollick exhibited mounted specimens of new or noteworthy additions to the local flora and read the following memoranda in connection with them:

Since the fourth appendix to the Flora of Richmond County was published, about two years since, there have been many plants found which require recording. The full list, containing thirty-six species and varieties new in our Island's flora, will be published as usual in the *Bulletin of the Torrey Botanical Club*, as the fifth appendix. Reprints of the same will be distributed to all those desiring them. Memoranda in regard to some of the species have been published in our Proceedings,

while others have not been recorded, although of considerably interest.

For several years specimens of a peculiar *Ranunculus* were collected in the Clove Lake Swamp. They were classed under the species *fascicularis*, the common Early Buttercup, although plainly not identical with it. The most remarkable characteristic of all the plants was a tendency to fasciation which showed itself year after year, and may be seen in all the specimens collected. The species has lately been determined to be *Ranunculus septentrionalis*, Poir. Thus far it has not been found in any other locality on the Island.

In studying the herbarium of the late Wm. H. Leggett many plants were noted as having been collected on Staten Island. Amongst the most interesting were several specimens of *Lechea racemulosa*, Lam, from Tottenville, mixed with and included under the name of *L. thymifolia*, Michx.

Trifolium hybridum, L., supposed to be a hybrid between the Red and White Clovers, is becoming more common, and may be now found along many of the streets of New Brighton, and also on the filled-in ground at St. George.

A species of Honeysuckle was admitted into the last appendix under the name of *Lonicera ciliata*, Muhl. A single bush in flower was found in some cedar woods just north of Garretsons. It was undoubtedly native where found. Since then, Mr. Wm. T. Davis has discovered the plant, in fruit, in a similar situation at New Brighton. With the material now in our possession we are enabled to determine it to be *L. xylosteum*, L., the European Fly Honeysuckle, which has somehow become established and thoroughly naturalized here, probably through the agency of birds.

On May 30, 1888, a single plant of *Cynoglossum officinale*, L., was found in a field near Richmond. The only other time that this plant was reported from the Island was in 1880, when a single specimen was found near Concord.

Amarantus hybridus, L., in every stage of hybridization between the green Pigweed and the red Prince's Feather is common along the streets and in waste places in New Brighton.

Thus far I have failed to find a Butternut tree growing here independent of cultivation, but in the Trans. N. Y. State Agri. Soc., for 1843, there is a list of the trees common on Staten Island, by Dr. Samuel Ackerly, and this tree is included in the list, under the name of *Juglans cathartica*, Michx. It

is quite possible that at that time it may have been native here.

Mr. Wm. T. Davis has reported the discovery of several more trees *Betula nigra*, L., the Red or River Birch, near Richmond, Annadale and Old Place, but the total number of trees is so small that the speedy extermination of the species on the Island is certain.

Salix purpurea. L., the Basket Willow, has become established in several localities notably near Garretsons and Old Place. These trees no doubt originated from cuttings of cultivated trees which were thrown aside in rubbish heaps. At Garretsons their presence is easily accounted for by the old plantation belonging to the late John Reed, which has been cultivated for generations. No doubt at Old Place there was also a plantation, although no indication of it was noticed. A single isolated tree was found on a roadside near Woodrow.

A single tree of the Hemlock Spruce (*Tsuga Canadensis*, L.) was found near Old Place. It is a somewhat conspicuous object as it is the only large tree, and an evergreen at that, left standing in a recently cleared place of woodland, where all the surrounding hardwood trees have been cut down.

In the sandy soil at Mariners' Harbor, Watchogue and Kreischerville occurs abundantly a form of Cat Brier, which is clearly a variety of the common *Smilax glauca*, Walt. The leaves are narrow and elongated, often constricted in the middle so as to be almost fiddle-shaped, and the stem, especially at the base, is thickly beset with prickles. It agrees with the description of the so-called *S. spinulosa.* Smith.

Several of the plants admitted into our catalogue without having been personally seen have been discovered within the past two years. Amongst them may be mentioned *Lathyrus maritimus*, (L.) Bigel., the Beach Pea. This was admitted on the authority of a specimen in the herbarium of the late Dr. Samuel Elliot and it now turns up at New Dorp near the old race course.

Pycnanthemum incanum, (L), Mich., admitted on the same authority, grows on Ocean Terrace.

Salix tristis, Ait., the Dwarf Gray Willow, was credited to Staten Island about twenty years ago in the *Bulletin of the Torrey Botanical Club.* There is a small patch growing south of the railroad between Richmond Valley and Tottenville, within a few yards of the hybrid oaks described in our Proceedings for September and October, 1888, which is probably the same locality where it was originally found.

Sabbatia dodecandra, (L.) (*S. chloroides*, Pursh.,) was reported by Mr. E. M. Eadie from near Chelsea. It was found in the Autumn of 1887 growing abundantly on the salt meadow near Kreischerville.

Dr. N. L. Britton showed specimens of yellow gravel and kaolin and remarked upon a recent discovery of another exposure of the Cretaceous strata which are known to underlie a considerable portion of Southfield and Westfield. This new exposure is on the Fingerboard Road about a quarter of a mile east of Grassmere Station. A cutting in the north side of the road shows a section of glacial and modified drift, under which may be seen some of kaolin similar to that which is so extensively dug near Kreischerville. This is associated with a small amount of yellow gravel. He stated that it could not be positively determined whether the kaolin was exactly in place or had been ploughed up from below and enclosed in the moraine as at the Prince's Bay bluff, already described in the Proceedings, November 8th, 1884.

SCIENTIFIC NEWS.

NATURAL HISTORY AT THE PARIS EXPOSITION.—Although the Paris Exposition has no special biological department, it cannot be said that biology is entirely unrepresented. The Woods' and Forests' Building, in the Gardens of the Trocadero, is composed of trunks and branches of trees native to or naturalized in France, all labelled with their botanical and French names, and the gallery around its interior has a collection of the seeds, leaves, resins, etc., of those trees, as well as of the fungi and insects injurious to them. Around this building are planted examples of native and introduced trees. The exhibit of the Transvaal Republic, in the Invalides Gardens, has a series of the eggs of many South African birds; the Argentine Republic, besides an extensive collection of woods, including many Legumenosæ and Rubicæ, *Zuglans Australes*, species of Myrsine, and large sections of *Cedrela brasiliensis*, has a set of fishes, reptiles, etc., preserved in alcohol, and Gautemala puts forward a fine collection of insects, and quite a number of birds. Most of the exhibits of the smaller and less important countries devote, in fact, a considerable space to their minerals, plants and animals, and this is true not only with regard to America, Australia and Africa,

but also, so far as regards minerals, of some European lands. The United States, important and extensive though it is, and varied though are its products, has nothing biological, and would have nothing mineral were it not for the enterprise of Dr. A. E. Foote, of Philadelphia, and of the exhibitor of the petrified trees of Arizona. Ethnography has not been neglected in the western or Industrial Arts wing, where Greeks are shown painting, pottery, Egyptians engaged in weaving and in agricultural work; and various semi-civilized or barbarous tribes occupied in their primitive methods of manufacture. Part of a hall in this wing of the main building is devoted to illustrations of the anthropology of criminality; and not far away from this a series of wax models, in a private exhibit, showing the effects of cutaneous and syphilitic diseases upon the person, is more pathological than pleasing or moral, but proves very attractive. As a parallel to the last-mentioned exhibit, the veterinary collection in one of the structures near the river may be noticed. Here also the monsters and malformations excite much more interest than anything normal. In the western gallery of the wing devoted to the Industrial or Liberal Arts is a miscellaneous geographical collection, which includes a rather extensive series of the results of the dredgings executed by the Travailleur and the Talisman in their various expeditions, together with the dredges used, and maps showing the course taken and the ocean depths. This collection contains many peculiar forms of fishes, including the renowned *Eurypharynx pelecanoides*, numerous crustaceans cirripeds, and pycnogonids, many echini, asteroids, crinoids and holothurians, and some gastropods lamellibra and brachiopods—all preserved in alcohol; also a dried collection of sponges and corals. Taken as a whole, the so-called "Liberal Arts" Department is the most unsatisfactory, most miscellaneous, and worst-arranged part of the entire Exposition. Perhaps, as time wears on, a catalogue may enable an enquiring visitor to see some order; but as it is, the various scholastic exhibits are an unexplained medley, and one is tempted to ask "Of what use are the few groups of historic, prehistoric and barbarous human beings, the meagre show of processes and results comprised under the head of 'Histoire de Travail,' and the very slim attempt at illustrating comparative anatomy, when within the bounds of the Exhibition itself—in the Trocadero Building—there is a first-rate ethnographical collection, and a splendid series of works illustrating French art

in all its phases? Would it not have been far better to have rounded out these collections with judicious additions, than to have made a separate, iusufficient exhibit?"

In a corner of the centre gallery of the Liberal Arts wing may be found a cast of *Phenacodus primævus* Cope, exhibited by its discoverer. If *P. primævus* could think, it would, like the Doge of Genoa at Versailles, be more surprised "to see itself there" than at anything else.

The aquarium in the Trocadero Gardens is well-stocked with a lively crowd of Cyprinidæ and Salmonidæ, including California salmon, but it has no marine animals.—*W. N. L.*

A course of six lectures on human embryology has lately been completed at Cornell University by Prof. Charles Sedgwick Minot, of Harvard Medical School; intended to supplement the practical course in chick development, given a year ago by Associate Professor Gage (who is in Europe this Spring). These lectures presented clearly the history of the ovum, karyokenisis, the germ layers, and the formation of certain organs, especially the heart. The closing discourse, on Theories of Heredity, was given on Thursday, the 9th of May, before a large audience of professors, trustees, advanced students and physicians.

RECENT BOOKS AND PAMPHLETS.

Annual Report for the Year 1888–9 of the Trustees of the American Museum of Natural History, Central Park, New York.

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Boulenger, G. A.—On the Chelydroid Chelonians of New Guinea.

———Description of a New Batrachian of the Genus *Eupemphix* from Trinidad. Extract from the Annals and Magazine of Nat. Hist. for April, 1889.

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———Note on Classification of the Ranidæ. Extract from Proceedings of London Zoological Society, March 20, 1888. From the Author.

Brongniart, Charles.—Les Insectes Fossiles des Terrains Primaires. Extrait du Bull. de la Société des Amis des Sciences Naturelles de Rouen (année 1885).

———Les Entomophthorées et leur application à la destruction des insectes nuisibles.—Sur un gigantesque neurorthoptère, provenant des terrains houillers de Commentry (Allier).—Les Blattes de l'époque houillère·—Sur un nouveau Poisson fossile du terrain houiller de Commentry (Allier). From the Author.

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Chapman, Frank M.—Preliminary Description of Two Apparently New Species of the Genus *Hesperomys* from Florida—A New Sub-Species of the Genus *Sigmodon* from Florida.—On the Habits of *Neofiber alleni* True.—Extracts from Bull. Am. Mus. Nat. Hist., Vol. II., No. 3, June 7, 1889. From the Author.

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Dugés, Alfredo.—Sur du espéces nouvelles des Ophidiens de Mexique. Read before the Am. Philosophical Soc., May 4, 1888. From the Author.

Edwards, Chas. L.—The Influence of Warmth upon the Irritability of Frogs' Muscle and Nerve. From the Author.

Forbes, S. A.—On the Food Relations of Fresh Water Fishes. Bull. Ill. State Lab. Nat. Hist., Vol. II. From the Author.

Frazer, Persifor.—Reply to Articles Concerning the American Committee of the International Congress of Geologists, by Prof. J. D. Dana and Maj. Powell, in Am. Journ. of Science for Dec., 1888. From the Author.

Garman, Sam.—An Andenn Medal.—The Batrachia of Kalm's "En Resa til Norra America." From the Bull. of the Essex Institute. Vol. XX., 1888.

————On the Lateral Canal System of the Selachia and Holocephala. Bull. of the Museum of Comparative Zoology, Vol. XVII., No. 2, Harvard College.

————A Large Carp and its History. Reprint from the Proceedings of the Boston Soc. Nat. Hist. From the Author.

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Wheeler, Joseph.—The Tariff and the Farmers. From the Author.

Whiteaves, J. F.—Illustrations of the Fossil Fishes of the Devonian Rocks of Canada. Extract from Trans. Roy. Soc., Canada. From the Author.

Wiedersheim, R.—Grundriss der Vergleichenden Anatomie der Wirbelthiere für Studirende. From the Editor.

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